DOCUMENT RESUME

ED 230 764 CE 036 218

AUTHOR	Dunn, James
TITLE	Machine Shop Lathes.
INSTITUTION	Oklahoma State Board of Vocational and Technical Education, Stillwater. Curriculum and Instructional Materials Center.
PUB DATE	83
NOTE	508p.; For a related document, see ED 212 879.
AVAILABLE FROM	Curriculum and Instructional Materials Center, 1515 West Sixth Avenue, Stillwater, OK 74074 (In-State: $6.50--Teacher, $5.50--Student; Out-of-State: $20.00--Teacher, $17.50--Student).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF02 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Behavioral Objectives; Competence; Competency Based Education; *Learning Activities; *Machine Tool Operators; *Machine Tools; Postsecondary Education; Secondary Education; *State Curriculum Guides; Test Items; *Trade and Industrial Education; Transparencies
IDENTIFIERS	Oklahoma

ABSTRACT

This guide, the second in a series of five machine shop curriculum manuals, was designed for use in machine shop courses in Oklahoma. The purpose of the manual is to equip students with basic knowledge and skills that will enable them to enter the machine trade at the machine-operator level. The curriculum is designed so that it can be used in full-time secondary and postsecondary classes as well as part-time adult classes. The manual includes four instructional units covering the following topics: shapers, introduction to lathes, engine lathe operations, and turret lathe operations. All of the units follow a standardized format that includes performance objectives, suggested activities for the teacher, information sheets, assignment sheets, job sheets, transparency masters, tests, and answers to tests and assignment sheets. All of the unit components focus on measurable and observable learning outcomes, and assignment sheets as well as job sheets are directly related to the lesson and provide for practice with pencil, paper, and actual hands-on jobs using the machinery of the trade. (KC)

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ED230764

Machine Shop Lathes

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83-001744

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State Department of Vocational and Technical Education
Stillwater, Oklahoma 74074

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FOREWORD

In Oklahoma, vocational educators have a basic belief that quality vocational programs require the use of sound instructional materials. It is this belief that prompted the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center to develop a curriculum tailored to provide high-quality and uniform training materials for the machinist trade. *Machine Shop Lathes* is the second in a series of five machine shop curriculum manuals to be published. The first manual, *Machine Shop I,* provides information basic to the machinist trade. *Machine Shop Lathes* is designed to allow the student to specialize in lathe operations.

Industry representatives, classroom teachers, and technical specialists collaborated closely to produce materials that will provide each student with information and practical learning experiences directly applicable to the machinist trade. Whether the students are just entering the trade, seasoned machinists upgrading skills, or skilled machinists reviewing procedures and using these materials as reference, they can appreciate the expertise of all those who created *Machine Shop Lathes.*

The information in *Machine Shop Lathes* should be adapted, personalized, and localized so that this publication will become a vital part of the teaching/learning process. It is my sincere hope that *Machine Shop Lathes* and the other manuals in this series will contribute to the development of a competent, safety-conscious workforce in the machine shop trade.

Francis Tuttle, Director
Oklahoma State Department of
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PREFACE

The purpose of *Machine Shop Lathes* is to equip students with basic knowledge and skills that will enable them to enter the machine trade at the machine-operator level.

This curriculum has been designed so that it may be used in full-time secondary and post-secondary classes, as well as part-time adult classes. It can also be adapted to open-entry, open-exit programs so that each student may progress at his or her own pace.

The assignment sheets and job sheets are the chief strengths of this volume. They are directly related to the lesson and provide for appropriate practice with pencil and paper and actual hands-on jobs using the machinery of the trade. The material is competency based in that the objectives of each unit are measurable to a minimum standard of acceptance.

Machine Shop Lathes should supplement *Machine Shop I*, but the subject material in the manual is not necessarily arranged in the order of instruction. It is recommended that the instructor arrange the units in this volume to meet individual teaching needs. All or part of a unit may be taught at a given time.

A skilled instructor who can supplement, personalize, and localize this material will go a long way toward helping the learner advance in the machine trade, which is changing at a fantastic rate. These changes have created a great demand for workers with job-ready skills.

James Dunn, Trade and Industrial
Curriculum Specialist

MACHINE SHOP LATHES

TABLE OF CONTENTS

Unit I Shapers 1
Unit II Introduction to Lathes 109
Unit III Engine Lathe Operations 255
Unit IV Turret Lathe Operations 463

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USE OF THIS PUBLICATION

Instructional Units

Machine Shop Lathes includes four instructional units. A standard format was established in 1970 for the development of instructional materials for all Oklahoma vocational teachers. This format includes eight basic components that form a unit of instruction: performance objectives, suggested activities for the teacher, information sheets, assignment sheets, job sheets, transparency masters, tests, and answers to tests and assignment sheets. Depending on the specific objectives, transparency masters, assignment sheets, and job sheets may or may not be included in the unit of instruction.

All of the unit components "zero in" on measurable and observable learning outcomes. Teachers are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the teacher will help him or her determine the following

A. Amount of material that can be covered in each class period
B. Skills that must be demonstrated
    1. Supplies and equipment needed
    2. Amount of practice needed
    3. Amount of class time needed for demonstrations
C. Supplementary materials, such as pamphlets and filmstrips, that must be ordered
D. Resource people who must be contacted

Performance Objectives (white pages)

Each unit of instruction is based on the performance needed for successful employment in an occupational area. Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction, and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching/learning process, it is important that teachers and students have a common understanding of the intent of the objectives. Following is a list of performance terms, their meanings, and behavioral synonyms that may have been used in this material.

A. Name — The individual supplies a name for objects, events, or people

Behavioral synonyms: Label, list, letter, record, reiterate, repeat, write.

B. Identify — The individual selects a named, described, or pictured object by pointing to it, touching it, picking it up, or selecting it

Behavioral synonyms: Select, mark, match, choose, judge

C. State a rule — The individual communicates a relationship or principle that could be used to solve problems or perform a task

D. Apply a rule — The individual supplies an answer to a problem by using a stated relationship or principle

Behavioral synonyms: Solve, calculate

E. Describe — The individual relates sufficient characteristics or properties of an object or event so that a second individual will be able to state what is being discussed

Behavioral synonyms: Define, discuss, interpret, recite, tell how, tell what happens when

F. Distinguish — The individual selects an object or event from two or more that are easily confused

Behavioral synonyms: Discriminate, differentiate

G. Order — The individual arranges three or more objects or events in a sequence based on a stated property

Behavioral synonyms: Arrange, sequence, list in order, classify, divide, isolate, sort

H. Construct — The individual makes a physical object, a verbal statement, or a drawing

(NOTE: *Construct* is used when the finished product or result is important.)

Behavioral synonyms: Draw, make, build, design, formulate, reproduce, transcribe, convert, put together, compile

I. Demonstrate — The individual performs several operations necessary to carry out a specified process

(NOTE: *Demonstrate* is used when it is desirable to watch the student perform a task, one of the highest levels of student performance.)

Behavioral synonyms: Show your work, show procedure, perform an experiment, perform the steps, operate, remove, replace, turn off/on, (dis)assemble, (dis)connect

The objectives should be provided for students and stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Prepare for each unit by deciding how each objective can best be taught.

The objective sheet may be also used as a quick pretest to determine prior knowledge of students and to determine whether further study or activities are necessary. Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When changes in objectives are made, the teacher should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

ACKNOWLEDGEMENTS

Planning and Reviewing Committee

I am indeed grateful for the generous contribution of time, expertise, and cooperation given by committee members and the schools or industries they represent.

Special thanks to Mercury Marine; Kobe, Inc.; and Halliburton Services for releasing employees to serve on the committee. *Machine Shop Lathes* would not have become a reality without the combined efforts of the following:

Larry Crow — Kobe, Inc., Oklahoma City, Oklahoma
Mitchell Slemp — Mid-America AVTS, Wayne, Oklahoma
Larry Veatch — Pioneer AVTS, Ponca City, Oklahoma
Wesley Taylor — Caddo-Kiowa AVTS, Fort Cobb, Oklahoma
Ken Hulsizer — Indian Meridian AVTS, Stillwater, Oklahoma
Eldon Richey — O.T. Autry AVTS, Enid, Oklahoma
Ralph Moore — Tulsa AVTS at Peoria, Tulsa, Oklahoma
Irving North — Mercury Marine, Stillwater, Oklahoma
Kenneth Morgan — Halliburton Services, Duncan, Oklahoma
Bill Whitmore — St. Brian Valley Career Center, Longmont, Colorado
Doug Plum — Technical Vocational Institute, Albuquerque, New Mexico
James Hilton — Krump AVTS, Krump, Tennessee
Sammie Smith — Krump AVTS, Krump, Tennessee
Bill Hill — State Department of Vocational and Technical Education, Stillwater, Oklahoma

Special thanks to Ken Robb, Tulsa AVTS at Memorial, for his assistance in proofing final copies of this manual.

I would also like to express my appreciation to the following companies for granting permissions for many of the illustrations used in this manual.

The Warner & Swasey Company, Cleveland, Ohio
Colchester Lathes, Clausing Machine Tools,
Elgin, Illinois
American Steel Foundries, Chicago, Illinois

Special thanks to Ken Hulsizer, Machine Shop Instructor, and to the administrative staff at Indian Meridian AVTS, Stillwater, Oklahoma, for their cooperation in the development of this publication.

Deep appreciation is expressed to my co-workers Joyce Sawatzky and Robert Hilley, who patiently trained and assisted me during the development of this curriculum. Sincere appreciation is extended to Bob Patton for giving me the opportunity to write this curriculum and for providing superior leadership during the development and publication of this manual. A great deal of the credit for the readability and clarity of this material goes to the CIMC editing staff under Terra McCluskey. Their help and guidance, their attention to detail, and their concern for a quality product were invaluable in completing this project. My gratitude goes to Terri Perry, Susan Walker, Jerry Weir, Sue Buck, and Barbi Harrison.

Special recognition goes to staff members from the Curriculum and Instructional Materials Center and the Graphics Division of the State Department of Vocational and Technical Education for their services offered during the development and publication of this manual. Most notably, recognition goes to Nancy Hilley, who provided many of the excellent illustrations used to supplement the instructional materials, and the members of the Communications Center, who, under the supervision of Jenny Fowler, typed and typeset the many drafts and revisions required during development. Those most involved in the typing for this volume include Pat Tate, Lori White, and Crissie Wickham. Finally, the services of the Print Shop, under Noel Wilcoxson, produced the quality appearance of this material.

Suggested Activities (pink pages)

This component is included only in teacher material. The suggested activities page assists teachers during the preparation stage of the teaching/learning process by providing suggestions for delivery and/or presentation during the instructional process. Read the suggested activities before teaching the units so that supplemental materials can be obtained, audiovisual materials prepared, and outside resources contacted. Duties of the teacher will vary according to the particular unit.

The references that are listed are ones used in the development of each unit. They should be used by the teacher to supplement knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

Information Sheet (green pages)

The information sheet provides "must know" content essential for meeting the cognitive (knowledge level) objectives of the unit. The information is written in a topical outline form and is keyed to the specific objectives.

Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. The information sheet may also be used for coordination activities and advisory committees.

Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide motivation for each unit.

Transparency Masters (white pages in teacher material and green in student material)

Transparency masters provide information in a special way. Transparencies direct the class' attention to the topic of discussion. Transparencies may present new information, or they may reinforce information presented in the information sheet. They are particularly effective when identification is necessary. Transparencies should be made and placed in the notebook where they will be immediately available for use.

Assignment Sheets (brown pages)

Assignment sheets give students a chance at problem solving, self-assessment, and/or practical experience with the information. They assist students in the application of knowledges which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided when appropriate and can be used by the student and/or teacher for checking student progress.

Job Sheets (blue pages)

Job sheets are another important segment of a unit of instruction. The job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomoter skill. They describe a step-by-step procedure needed to complete each task or job. Diagrams, photographs, and illustrations are provided to assist students in achieving the skill.

A teacher should demonstrate to students the procedures outlined in each job sheet. Furthermore, the teacher needs to localize the job sheet according to the equipment and supplies available in the local lab or shop situation. Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

Tests (yellow pages)

This component provides criterion-referenced evaluation of every objective listed in the unit of instruction. It is crucial to note that both paper/pencil and performance objectives must be evaluated.

The tests may be written or oral. It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of questions from the units covered may be used for final tests at the end of each term if desired. If objectives have been added, deleted, or modified, be sure to make the changes on the test.

The acceptable response on a unit test — 85 percent in most units — may be raised or lowered to fit the topic or students' ability levels. The percentage applies to the overall score, not to each question. The final unit grade should be obtained by using the paper/pencil score along with teacher evaluations of student demonstrations of the desired skills.

Answers to Test and Assignment Sheets (pink pages)

These components are designed to assist the teacher in evaluation of student performances.

Page Numbering

Each publication from the Curriculum and Instructional Materials Center is assigned a specific abbreviation. For example, *Machine Shop Lathes* has been abbreviated MS II. The units are then numbered consecutively. An example of a page number is MS II-1. Since CIMC publications are loose leaf, this system of page numbering was adopted so that pages from different manuals would not get mixed up.

Methods of Disseminating Material

Material may be given out a unit or page at a time to keep the material before the student always new. Some teachers ask students to furnish a three-ring binder for the units. This is more convenient for taking the materials home to study. Upon completion, each unit is placed in a larger binder. The large binders may be purchased at cost from the CIMC. Some teachers store the materials by units in filing cabinets or boxes until needed. All the units may be given out at once if desired.

Student materials should be provided for each student for best results. Student materials contain everything but the test answers, answers to assignment sheets, and suggested activities. All tests are collated at the back of student material and should be removed and stored until needed. Students should be allowed to take their materials home at the end of the year.

Teaching Methods

It is a challenge to keep students motivated. Supplement the objectives by providing the "why," personal experiences, and current information. Prepare for each unit by deciding how each objective can best be taught. Allow students to become involved in preparing and planning.

SHAPERS
UNIT I

UNIT OBJECTIVE

After completing this unit, the student should be able to identify different types of shapers and their attachments, apply all rules for the safe use of the shaper, and set correct speeds and feeds. The student should also be able to grind shaper tools; align a vise square and flat and perform squaring, flat, angular, and slotting operations. This knowledge will be shown by completing assignment sheets, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with shapers to their correct definitions.
2. Name types of shapers.
3. Identify parts of the standard crank shaper.
4. Identify work-holding devices.
5. State rules for care and cleaning of the shaper.
6. State rules for safe use of the shaper.
7. Name types of shaper cutting tool materials.
8. Identify angles of shaper cutting tools.
9. Identify shapes of high-speed steel cutting tools.
10. Label types of shaper toolholders.
11. Name methods of holding cutting tools.
12. Name factors that affect speed and feed settings.
13. Calculate number of strokes per minute.
14. Identify shaper operations.
15. Complete safety test for shaper.
16. Calculate number of strokes per minute and determine feed settings.
17. Demonstrate the ability to
    a. Grind a right-hand roughing tool.
    b. Grind a fillet cutting tool.

OBJECTIVE SHEET

c. Grind a V-shaped tool.

d. Align vise square and flat.

e. Set length of stroke and position ram.

f. Set speeds and feeds.

g. Cut internal and external keyways.

h. Cut a part square and flat.

i. Cut an angular surface.

j. Cut slots and grooves.

SHAPERS
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities

   A. Make transparencies.

   B. Provide students with objective sheet.

   C. Provide students with information and assignment sheets.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Demonstrate basic operating procedures of the shaper.

   H. Give reasons for safety rules and stress their importance.

   I. Provide material to be used for job sheets.

   J. Give test.

   K. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM #1--Types of Shapers

      2. TM #2--Parts of the Standard Crank Shaper

      3. TM #3--Work-Holding Devices

      4. TM #4--Work-Holding Devices (Continued)

   E. Assignment sheets

      1. Assignment Sheet #1--Complete Safety Test for Shaper

      2. Assignment Sheet #2--Calculate Number of Strokes per Minute and Determine Feed Settings

SUGGESTED ACTIVITIES

F. Answers to assignment sheets

G. Job sheets

  1. Job Sheet #1--Grind a Right-Hand Roughing Tool
  2. Job Sheet #2--Grind a Fillet Cutting Tool
  3. Job Sheet #3--Grind a V-Shaped Tool
  4. Job Sheet #4--Align Vise Square and Flat
  5. Job Sheet #5--Set Length of Stroke and Position Ram
  6. Job Sheet #6--Set Speeds and Feeds
  7. Job Sheet #7--Cut Internal and External Keyways
  8. Job Sheet #8--Cut a Part Square and Flat
  9. Job Sheet #9--Cut an Angular Surface
  10. Job Sheet #10--Cut Slots and Grooves

H. Test

I. Answers to test

III. Unit references

A. Kibbe, Richard R., et al. *Machine Tool Practices*. New York: John Wiley and Sons, Inc., 1979.

B. Krar, S. F.; J.W. Oswald, and J.E. St. Amand. *Technology of Machine Tools*. Toronto: McGraw-Hill Co. of Canada, Ltd., 1969.

C. McCarthy, Willard, and Robert Smith. *Machine Tool Technology*. Bloomington, Illinois: McKnight Publishing Co., 1968.

SHAPERS
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Reciprocation--Back and forth movement

   B. Ram--Main moving part of shaper; holds and drives cutting tool

   C. Toolhead--Part attached to front of shaper ram; holds clapper and cutting tool, swivels right and left, and feeds slide vertically

   D. Table--Metal box attached to frame; has T-slots on which work or work-holding devices are mounted; moves in horizontal or vertical direction with power or manual feed

   E. Stroke--Distance in inches that ram moves

   F. Clapper--Holds tool post that supports cutting tool

   G. Clapper box--Holds clapper with tool post and allows tool to move away from cut on return stroke

II. Types of shapers (Transparency #1)

   A. Standard crank

   B. Hydraulic

   C. Vertical

III. Parts of the standard crank shaper (Transparency #2)

   A. Clapper box

   B. Tool post

   C. Vise

   D. Clutch and brake lever

   E. Table support

   F. Table

   G. Base

   H. Cross-feed lever

INFORMATION SHEET

- I. Cross-feed shaft and safety crank
- J. Vertical-traverse shaft
- K. Rapid-traverse lever
- L. Back gear lever
- M. Stroke-adjustment shaft
- N. Electrical control box
- O. Length-of-stroke indicator
- P. Gearshaft lever
- Q. Feed-control lever
- R. Power switch
- S. Ram
- T. Ram positioning lock
- U. Ram positioning shaft
- V. Toolhead
- W. Down-feed handle

IV. Work-holding devices (Transparencies #3 and #4)

- A. Vise
- B. Fixture
- C. Angle plate
- D. C-clamp
- E. T-bolt
- F. Strap clamps
- G. Hold-down wedges
- H. Parallels
- I. Dividing head

INFORMATION SHEET

   - J. Foot stock
   - K. V-block
   - L. Step blocks

V. Rules for care and cleaning of the shaper

   - A. Cleaning--Clean with a brush when machine stops
   - B. Lubrication--Before operating, check all sight windows for proper oil level; fill all oil cups and grease fittings

     (NOTE: Check operator's manual for correct lubricant to be used.)
   - C. Locks--Never operate feed when lock is in locked position
   - D. Gear boxes--Never change gears while machine is operating
   - E. Stroke adjustments--Never adjust while machine is operating
   - F. Cranks--Remove all hand cranks from traverse and adjusting shafts before operating machine

VI. Rules for safe use of the shaper (Assignment Sheet #1)

   - A. Wear full face shield or approved safety glasses with side shields
   - B. Be sure vise, setup, or fixture is securely fastened to table before starting machine
   - C. Select proper tool and toolholder for job
   - D. Make sure tool, toolhead, and table supports are secure before starting machine
   - E. Never run ram into column when toolhead or toolholder is set at an angle
   - F. Remove wrenches before starting machine
   - G. Set speed, feeds, and depth of cut according to material being cut, cutting tool being used, and method of holding work
   - H. Do not pass hands between tool and work while machine is operating
   - I. Never touch tool, work, clapper, or any moving part while machine is operating
   - J. Use a brush to remove chips from work and machine; use only when machine is stopped

INFORMATION SHEET

K. Make measurements only when machine is stopped

L. Make adjustments only when machine is stopped

M. Handle machined work with great care and deburr sharp edges with a file

VII. Types of shaper cutting tool materials

A. High-speed steel

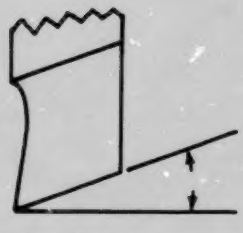
B. Carbide-tipped

EXAMPLE: Brazed, inserted

VIII. Angles of shaper cutting tools (Figures 1-4)

A. End relief

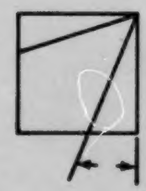
FIGURE 1



Side View

B. Side relief

FIGURE 2

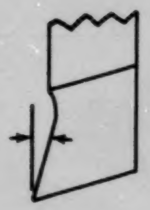


End View

INFORMATION SHEET

C. Back rake

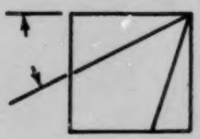
FIGURE 3



Side View

D. Side rake

FIGURE 4



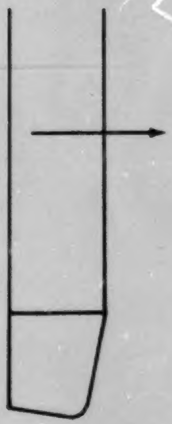
End View

IX. Shapes of high-speed steel cutting tools (Figures 5-15)

(NOTE: The following tools illustrate some basic shapes; many design variations exist. Tool material can be either high-speed steel or carbide-tipped. The arrows in the illustrations indicate the direction of feed.)

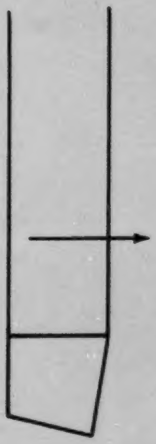
A. Left-hand roughing

FIGURE 5



B. Left-hand finishing

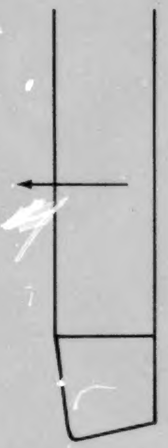
FIGURE 6



INFORMATION SHEET

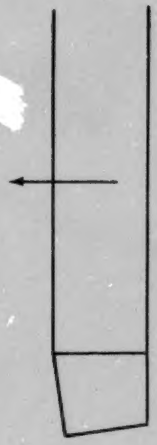
C. Right-hand roughing

FIGURE 7



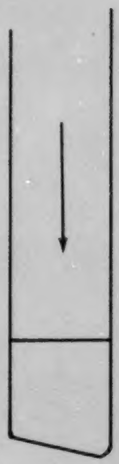
D. Right-hand finishing

FIGURE 8



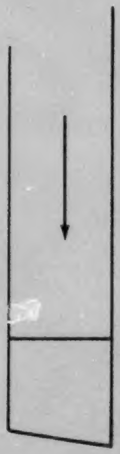
E. Left-hand side roughing

FIGURE 9



F. Left-hand side finishing

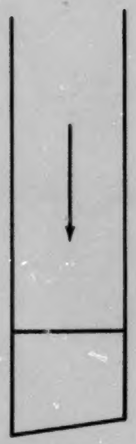
FIGURE 10



INFORMATION SHEET

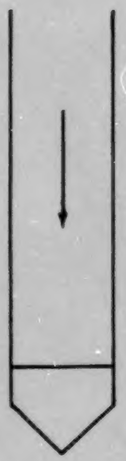
G. Right-hand side finishing

FIGURE 11



H. V-shape grooving

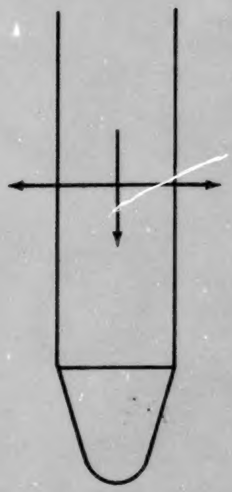
FIGURE 12



I. Round-nose contouring

(NOTE: Feed direction can be right, left, or down.)

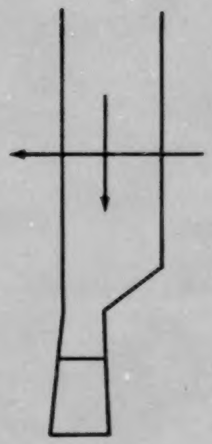
FIGURE 13



J. Slotting

(NOTE: Slotting tools can also be used for parting or surface finishing.)

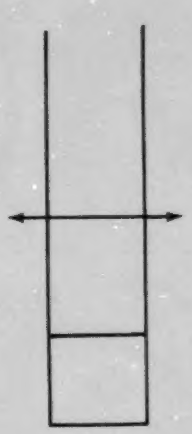
FIGURE 14



INFORMATION SHEET

K. Neutral square-nose finishing

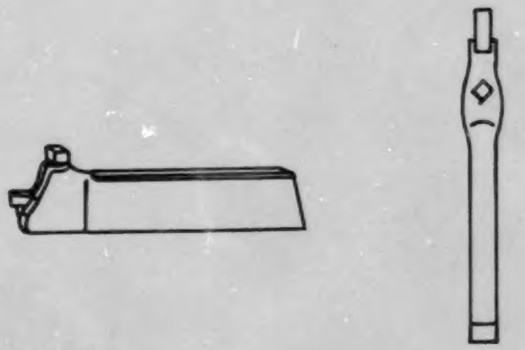
FIGURE 15



X. Types of shaper toolholders (Figures 16-20)

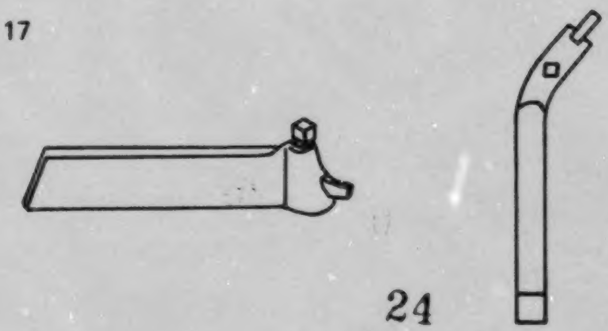
A. Straight

FIGURE 16



B. Offset right-hand

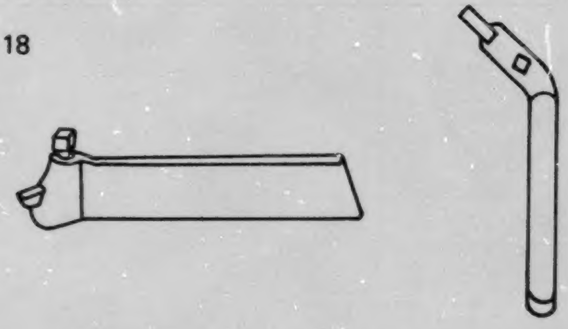
FIGURE 17



INFORMATION SHEET

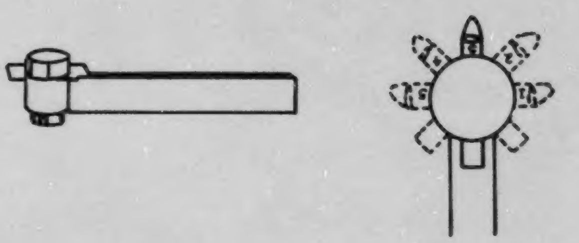
C. Offset left-hand

FIGURE 18



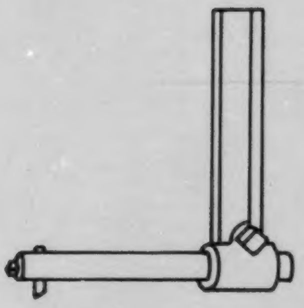
D. Multiposition

FIGURE 19



E. Extension bar

FIGURE 20

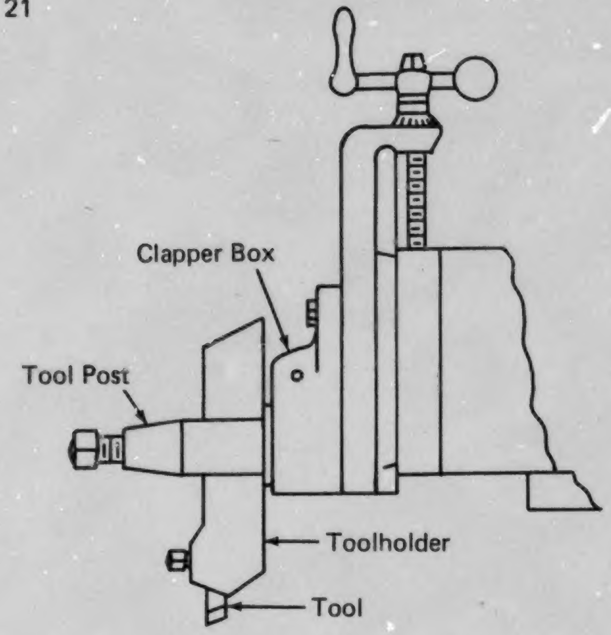


INFORMATION SHEET

XI. Methods of holding cutting tools (Figures 21-24)

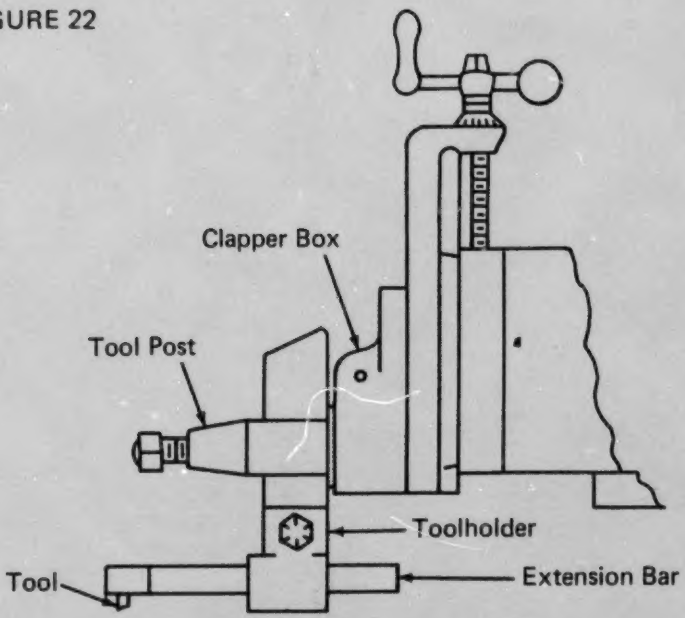
A. Tool mounted toolholder for external cutting

FIGURE 21


Clapper Box
Tool Post
Toolholder
Tool

B. Tool mounted toolholder for internal cutting

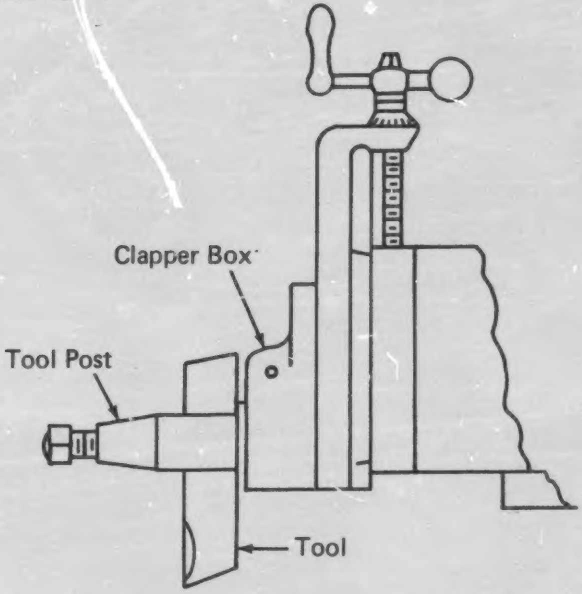
FIGURE 22


Clapper Box
Tool Post
Toolholder
Tool
Extension Bar

INFORMATION SHEET

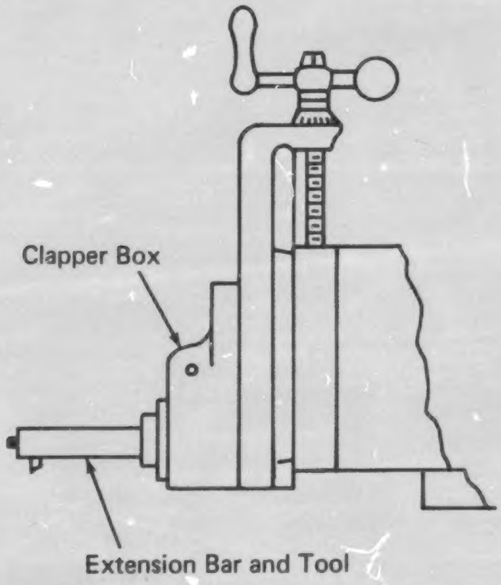
C. Tool mounted in tool post for external cutting

FIGURE 23


Clapper Box
Tool Post
Tool

D. Tool mounted in tool post for internal cutting

FIGURE 24


Clapper Box
Extension Bar and Tool

INFORMATION SHEET

XII. Factors that affect speed and feed settings

A. Cutting tool material

EXAMPLES: High-speed steel, carbide-tipped

B. Kind of material being machined (cutting speed)

EXAMPLE:

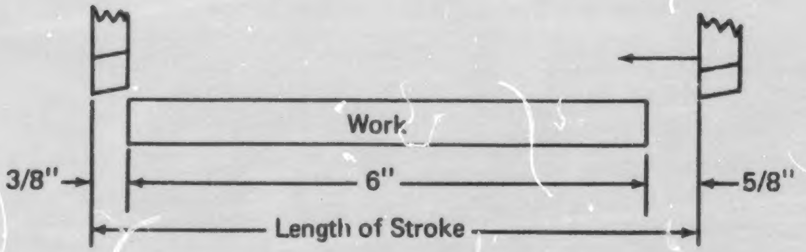
Material	Cutting Speed	
	HSS	Carbide
Cast iron	60	100
Machine steel	80	150

C. Length of stroke (length of cut plus 1")

(NOTE: The inch allows the cutter to clear the end of the cut and finish the stroke 1/4" to 3/8" before starting return. The remaining 5/8" to 3/4" allows the feed to complete its movement and the clapper to seat back in clapper box before starting stroke for next cut. See Figures 25 and 26.)

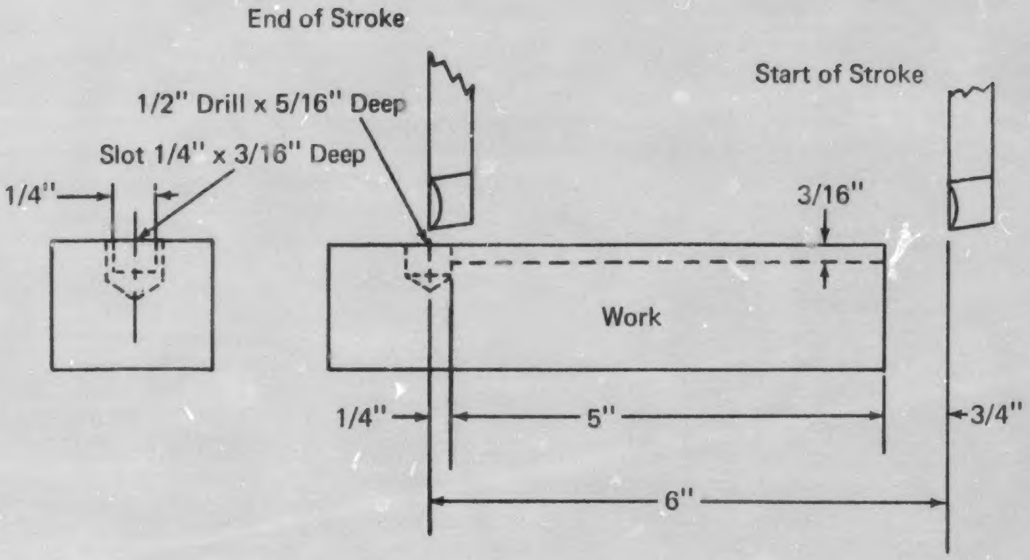
EXAMPLES:

FIGURE 25



INFORMATION SHEET

FIGURE 26


End of Stroke
Start of Stroke
1/2" Drill x 5/16" Deep
Slot 1/4" x 3/16" Deep
1/4"
3/16"
Work
1/4"
5"
3/4"
6"

D. Surface finish required

(NOTE: The finish is determined by the shape of the tool and the amount of feed per stroke. The feed range for different surface finishes can be found on the cutting speed and feed chart.)

EXAMPLES: Feed for cutting steel with HSS tool

Rough cut 0.010" to 0.020"
Finish cut 0.003" to 0.010"

INFORMATION SHEET

XIII. Calculating number of strokes per minute (Assignment Sheet #2)

A. Use chart to find cutting speed (CS) for kind of material being machined and tool being used

(NOTE: Cutting speed is expressed in feet per minute. Feed is expressed in inches. Feed figures are suggestions and may vary with different sources. The operator must use a certain amount of judgment when setting feed because feed movement must be completed before the tool starts its next stroke.)

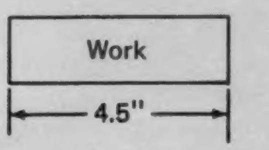
Material	Cutting Speed		Feed Rough Cut		Feed Finish Cut	
	HSS	Carbide	HSS	Carbide	HSS	Carbide
Cast Iron	60	100	0.010-0.020	0.020-0.030	0.003-0.010	0.005-0.012
Mach. Steel	80	150	0.010-0.020	0.012-0.025	0.003-0.010	0.003-0.010
Tool Steel	50	150	0.010-0.030	0.010-0.030	0.005-0.015	0.003-0.012
Copper	80	200	0.020-0.060	0.010-0.020	0.003-0.012	0.005-0.015
Brass	160	300	0.010-0.030	0.005-0.060	0.003-0.010	0.005-0.015
Aluminum	200	400	0.015-0.040	0.010-0.030	0.005-0.015	0.005-0.015

EXAMPLE: When cutting machine steel with high-speed cutting tool, the cutting speed (CS) is 80 feet per minute.

B. Determine length of stroke (L=length of cut plus 1") (Figure 27)

EXAMPLE:

FIGURE 27



L = 5.5"

C. Put the two variables in simplified shop formula

$$\text{Number of Strokes} = \frac{\text{Cutting Speed} \times 7}{\text{Length of Stroke}} \quad \text{or} \quad N = \frac{CS \times 7}{L}$$

(NOTE: Seven is a constant that is the combined ratio of time required for a forward and return stroke and a conversion of inches into feet. L represents length of stroke.)

EXAMPLE:

$$N = \frac{80 \times 7}{5.5}$$

$$= \frac{560}{5.5}$$

$$= 101.8$$

INFORMATION SHEET

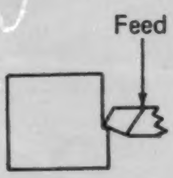
XIV. Shaper operations (Figures 28-38)

(NOTE: Arrows in all illustrations indicate relative movement of tool for the next cut unless otherwise noted.)

A. Machining flat surface with vertical cuts

(NOTE: Always feed toward solid jaw when possible.)

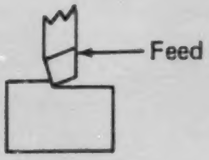
FIGURE 28



Vertical

B. Machining flat surface with horizontal cuts

FIGURE 29

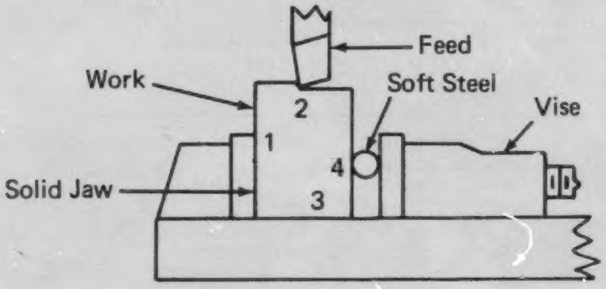


Horizontal

C. Machining part square or rectangular in vise

(NOTE: Numbers represent sequence for shaping sides.)

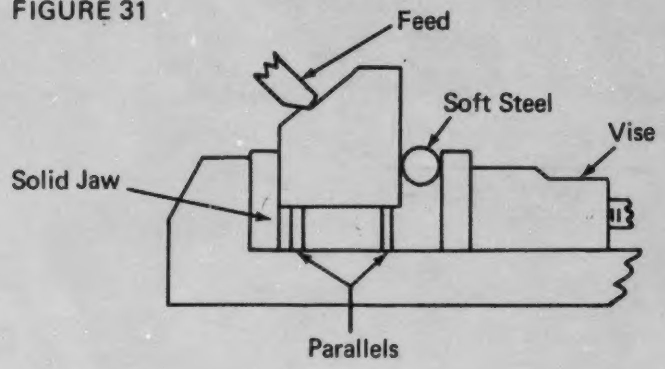
FIGURE 30



INFORMATION SHEET

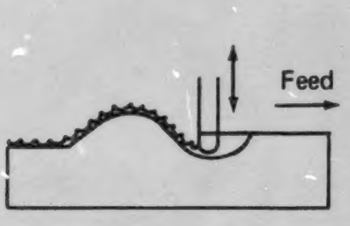
D. Machining angular surface

FIGURE 31


Feed
Soft Steel
Vise
Solid Jaw
Parallels

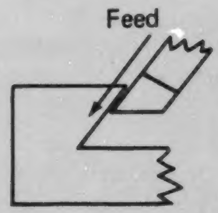
E. Machining contour surface

FIGURE 32



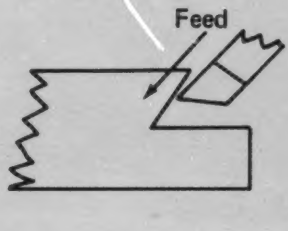
F. Machining internal dovetail

FIGURE 33



G. Machining external dovetail

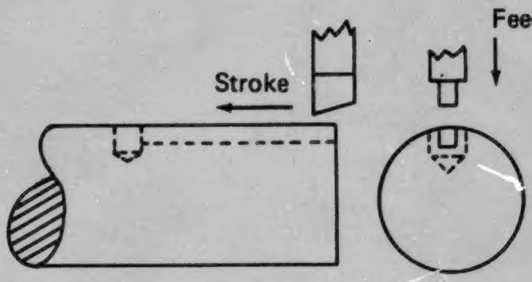
FIGURE 34



INFORMATION SHEET

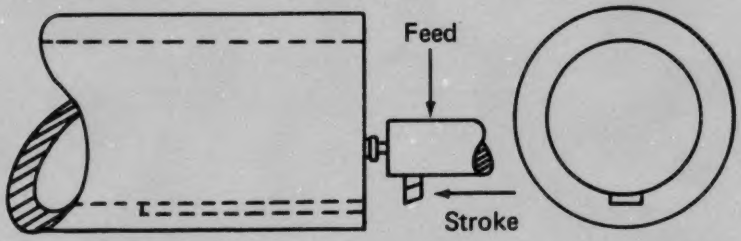
H. Machining external keyway

FIGURE 35


Feed
Stroke

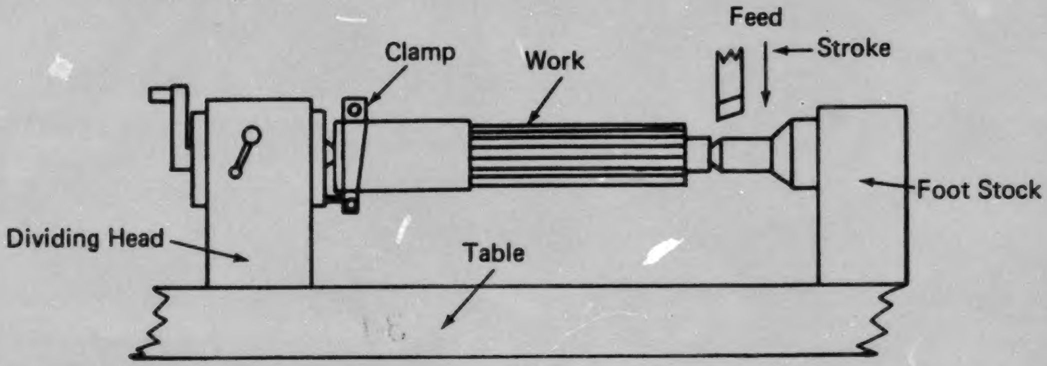
I. Machining internal keyway

FIGURE 36


Feed
Stroke

J. Machining a spline using dividing head

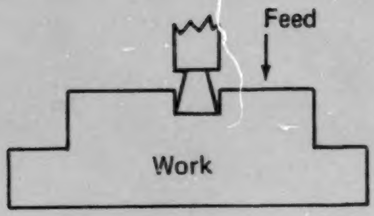
FIGURE 37


Feed
Stroke
Clamp
Work
Foot Stock
Dividing Head
Table

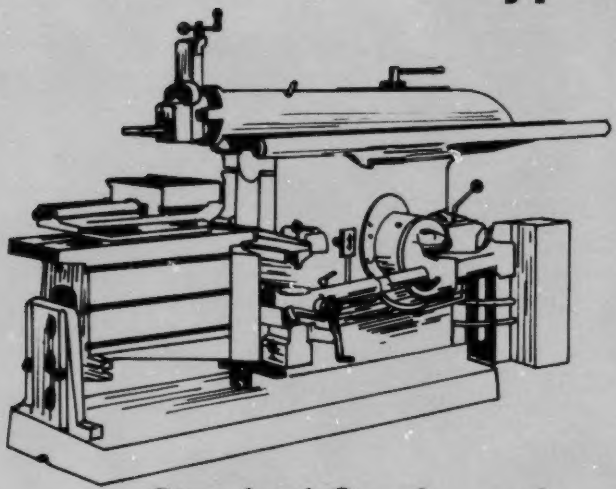
INFORMATION SHEET

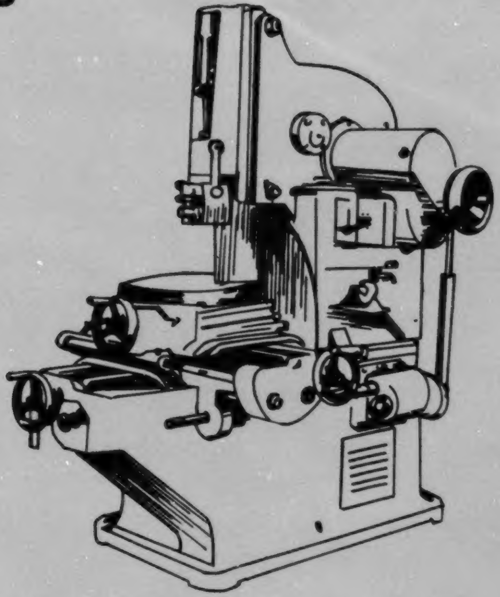
K. Machining a slot

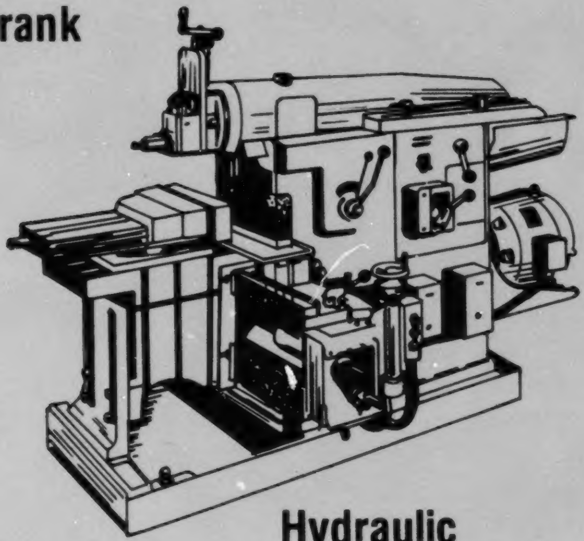
FIGURE 38



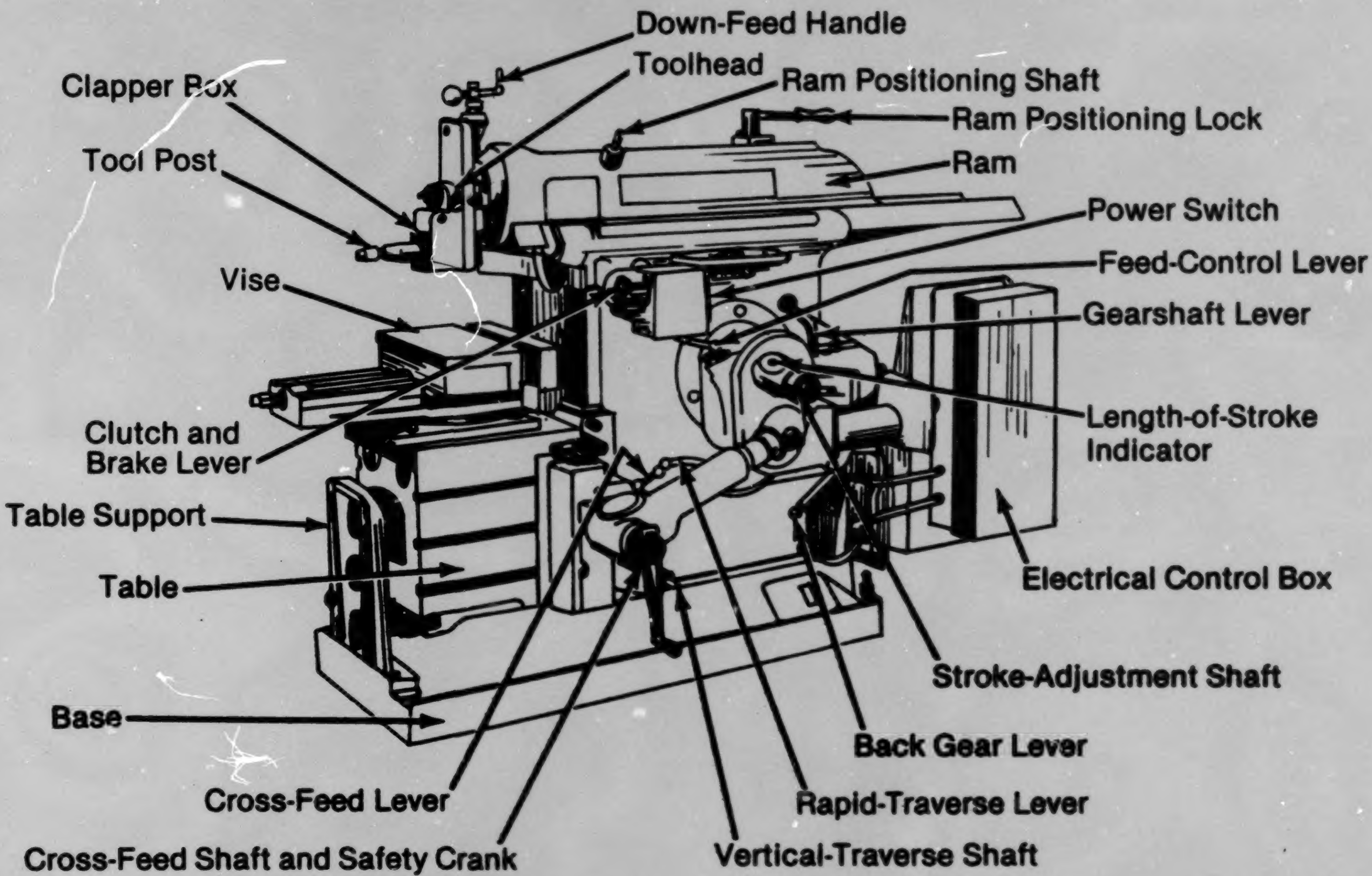
Types of Shapers


Standard Crank


Vertical


Hydraulic

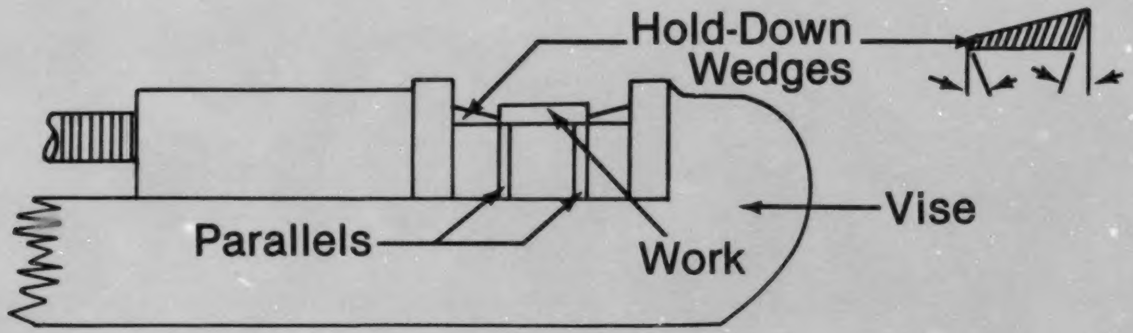
Parts of the Standard Crank Shaper

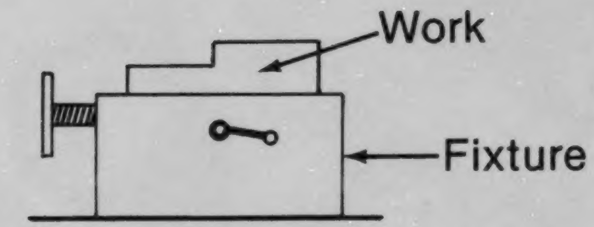

Down-Feed Handle
Toolhead
Clapper Box
Ram Positioning Shaft
Ram Positioning Lock
Tool Post
Ram
Power Switch
Vise
Feed-Control Lever
Gearshaft Lever
Length-of-Stroke Indicator
Clutch and Brake Lever
Table Support
Table
Electrical Control Box
Stroke-Adjustment Shaft
Base
Back Gear Lever
Cross-Feed Lever
Rapid-Traverse Lever
Cross-Feed Shaft and Safety Crank
Vertical-Traverse Shaft

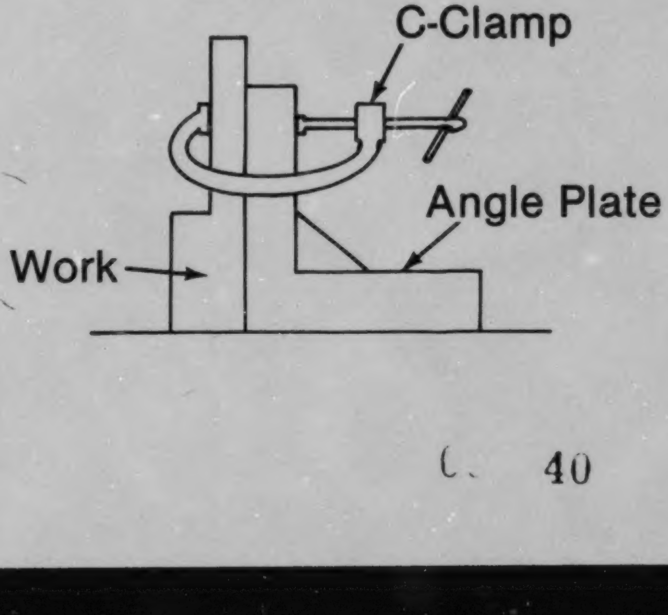
00 37

0 38

Work-Holding Devices

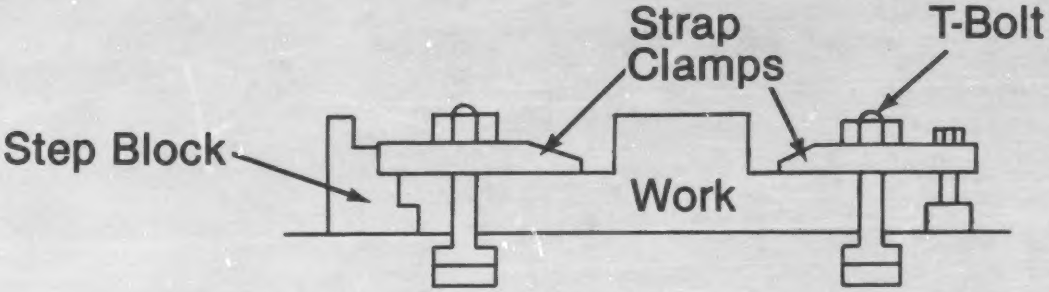

Hold-Down
Wedges
Vise
Parallels
Work

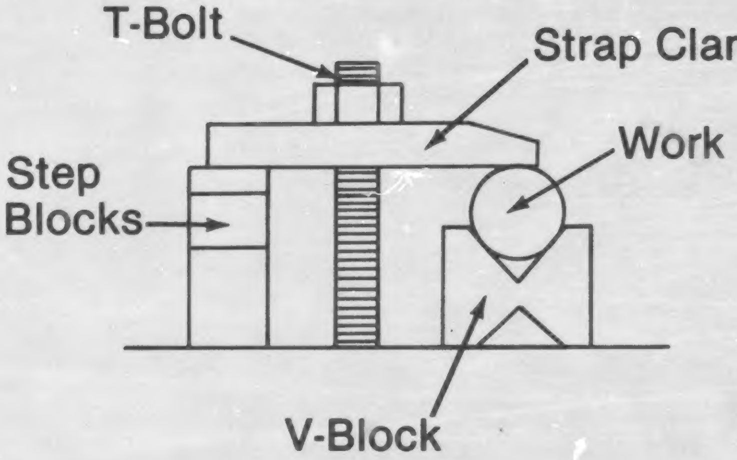

Work
Fixture

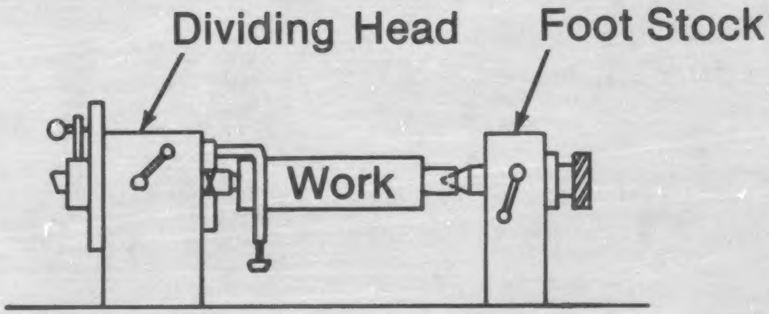

C-Clamp
Angle Plate
Work

Work-Holding Devices

(Continued)


Strap
Clamps
T-Bolt
Step Block
Work


T-Bolt
Strap Clamp
Work
Step
Blocks
V-Block


Dividing Head
Foot Stock
Work

SHAPERS
UNIT I

ASSIGNMENT SHEET #1--COMPLETE SAFETY TEST FOR SHAPER

NAME________________________________ SCORE______________

The shaper is an effective, inexpensive way to remove metal from work; however, because of the fixed work and the moving ram, it can also be dangerous if not given respect.

(NOTE: A score of 100 percent is required on this assignment sheet.)

State rules for safe use of the shaper with regard for each of the following areas.

A. Eyes-- ____

____

B. Work-holding devices-- ________________________________

____

C. Tools and toolholder-- ________________________________

____

D. Before starting machine--______________________________

____

E. Ram-- ____

____

F. Speeds, feeds, and depth of cut--_______________________

____

G. Between strokes-- _____________________________________

____

H. Touching-- ____

____

I. Chips-- ____

____

ASSIGNMENT SHEET #1

J. Measurements-- ______________________________

____

K. Adjustments-- ______________________________

____

L. Machined work-- ______________________________

____

M. Wrenches-- ______________________________

____

SHAPERS
UNIT I

ASSIGNMENT SHEET #2--CALCULATE NUMBER OF STROKES PER MINUTE AND DETERMINE FEED SETTINGS

NAME ______________________________ SCORE ______________

The proper number of strokes and amount of feed are the keys to removing the greatest amount of material with the maximum tool life between grindings.

Use the chart and formula provided below to calculate the number of strokes per minute and the feed rate for each of the jobs described.

Material	Cutting Speed		Feed Rough Cut		Feed Finish Cut	
	HSS	Carbide	HSS	Carbide	HSS	Carbide
Cast Iron	60	100	0.010-0.020	0.010-0.030	0.003-0.010	0.005-0.012
Mach. Steel	80	150	0.010-0.020	0.012-0.025	0.003-0.010	0.003-0.010
Tool Steel	50	150	0.010-0.030	0.010-0.030	0.005-0.015	0.003-0.012
Copper	80	200	0.020-0.060	0.010-0.020	0.003-0.012	0.005-0.015
Brass	160	300	0.010-0.030	0.005-0.060	0.003-0.010	0.005-0.015
Aluminum	200	400	0.015-0.040	0.010-0.030	0.005-0.015	0.005-0.015

$$N = \frac{CS \times 7}{L}$$

(NOTE: L = Length of cut plus 1-inch clearance.)

A. Find the number of strokes per minute for a shaper to machine a flat surface on a cast-iron plate 10" long and 5" wide; also, give the rough and finish feed range if the cutting tool is high-speed steel (HSS).

(NOTE: Cut along the 10" dimension.)

1. Number of strokes per minute = ______________________
2. Rough feed range = ______________________
3. Finish feed range = ______________________

ASSIGNMENT SHEET #2

B. Find the number of strokes per minute to cut a slot 7" long, 2" wide, and 0.5" deep in a plate of tool steel 7" x 5" x 1 1/2"; also, list the feed range for a finish cut using a cemented carbide tool.

1. Number of strokes per minute = ______________________________
2. Finish feed range = ______________________________

C. How many strokes per minute should be used to cut a 5/16" keyway 4" long on an aluminum shaft 11" long, using a tool of HSS?

Strokes per minute = ______________________________

D. How many strokes per minute would be required for cutting a flat surface on a machine steel bar using HSS tool if the length of the stroke, plus 1", is 11"?

Strokes per minute = ______________________________

E. Find the number of strokes per minute to machine a dovetail in a cast-iron plate with HSS tool. The length of the dovetail is 8".

Number of strokes per minute = ______________________________

SHAPERS
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

A. Wear full face shield or approved safety glasses with side shields

B. Be sure that vise, setup, or fixture is securely fastened to table before starting machine

C. Select proper tool and toolholder for job

D. Make sure tool, toolhead, and table supports are secure before starting machine

E. Never run ram into column when toolhead or toolholder is set at an angle

F. Set according to material being cut, cutting tool being used, and method of holding work

G. Do not pass hands between tool and work while machine is operating

H. Never touch tool, work, clapper, or any moving part while machine is operating

I. Use a brush to remove chips from work and machine; use only when machine is stopped

J. Make only when machine is stopped

K. Make only when machine is stopped

L. Handle with great care and deburr sharp edges with a file

M. Remove wrenches before starting machine

Assignment Sheet #2

A. 1. 38.18
   2. 0.010" to 0.020"
   3. 0.003" to 0.010"

B. 1. 131.25
   2. 0.003" to 0.012"

C. 280

D. 50.90

E. 46.66

SHAPERS
UNIT I

JOB SHEET #1--GRIND A RIGHT-HAND ROUGHING TOOL

I. Equipment and materials

   A. Pedestal grinder

   B. Grinding wheel dresser

   C. Goggles

   D. Steel-edged protractor

   E. Radius gauge set

   F. Oilstone

   G. Keystock, 3" long, correct width for toolholder

   H. High-speed steel tool bit blank to fit toolholder

II. Preparation for free-hand grinding

   (CAUTION: You must have passed the pedestal grinder safety test before performing this procedure.)

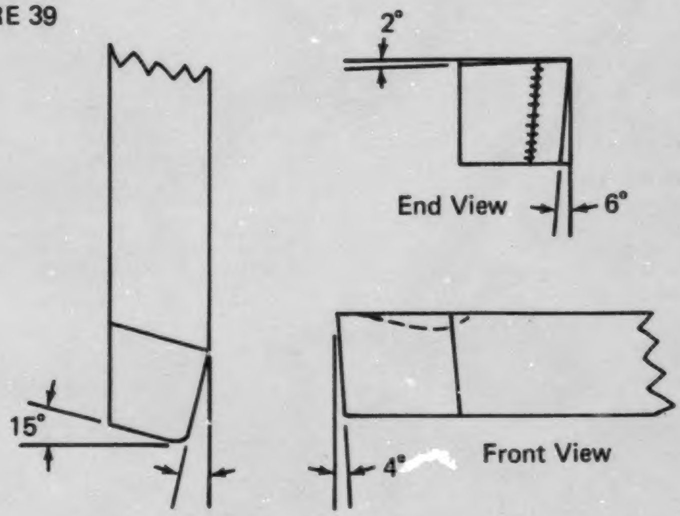
   A. Dress faces of both coarse and fine-grit aluminum oxide grinding wheels

   B. Stop grinder and adjust tool rest and spark breaker

JOB SHEET #1

III. Procedure for grinding a right-hand roughing tool with the shaper (Figure 39)

FIGURE 39

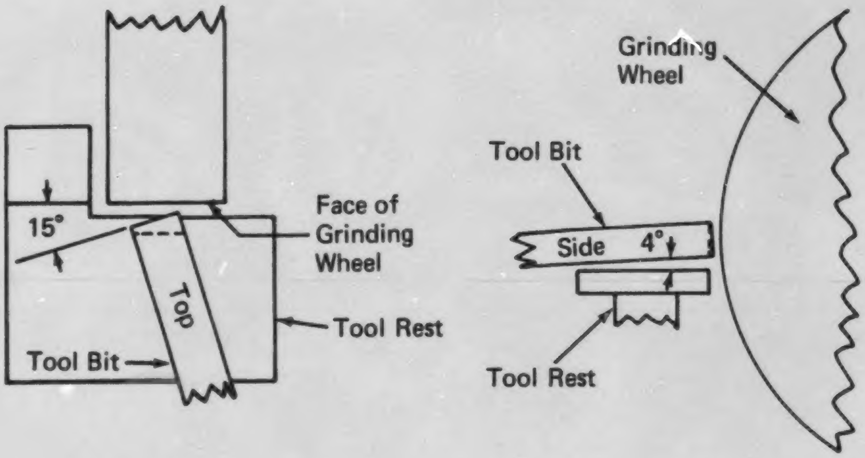

2°
End View
6°
15°
4°
Front View

A. Grind end cutting edge and end relief angles (Figure 40)

(NOTE: Use keystock for practice. Rough grind with the coarse wheel and finish the tool with the fine wheel.)

1. Hold end of tool to face of grinding wheel at approximately a 15° angle, with the end tilted up about 4°

FIGURE 40

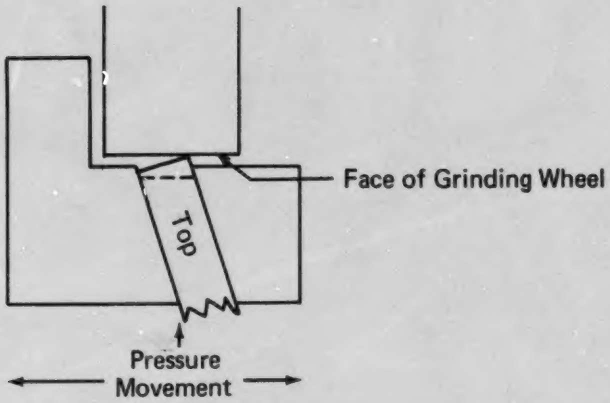

15°
Top
Tool Bit
Face of Grinding Wheel
Tool Rest
Grinding Wheel
Tool Bit
Side
4°
Tool Rest

JOB SHEET #1

2. Hold tool FIRMLY and bring end of tool into contact with grinding wheel; apply light pressure and move tool from side to side across face of wheel (Figure 41)

   (NOTE: Keep the tool cool by frequently dipping it in water; the cutting tool should never be permitted to change colors from heat generated by grinding.)

FIGURE 41

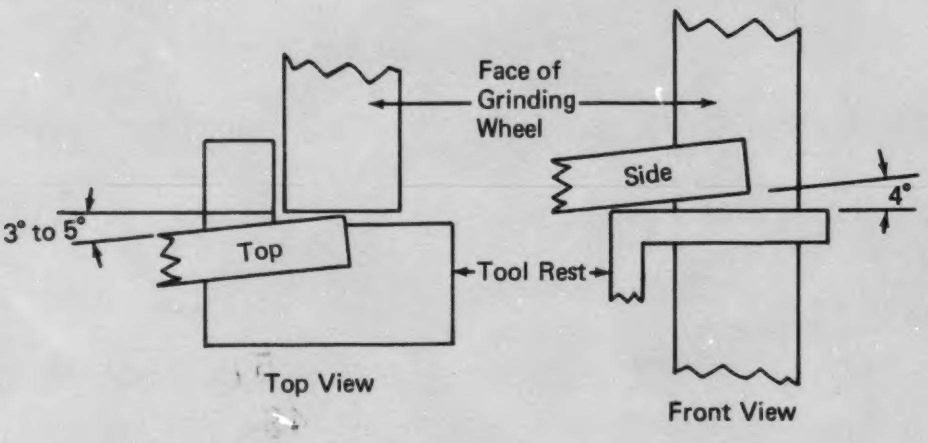

Face of Grinding Wheel
Top
Pressure
Movement

3. Continue to grind until end cutting edge is the width of tool and end relief angle extends from bottom to top of tool

B. Grind side cutting edge and side clearance angle

1. Hold cutting tool 3° to 5° to face of wheel, tilting cutting end up about 4° (Figure 42)

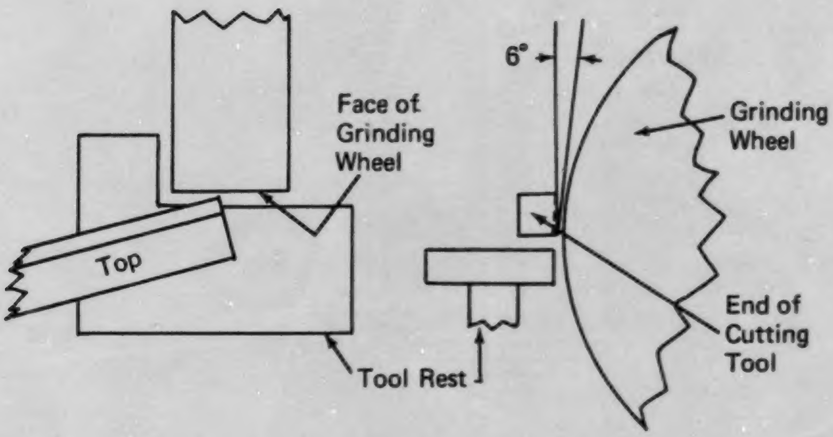
FIGURE 42


Face of Grinding Wheel
3° to 5°
Top
Tool Rest
Side
4°
Top View
Front View

JOB SHEET #1

2. Tilt top of tool away from face of grinding wheel about 6° (Figure 43)

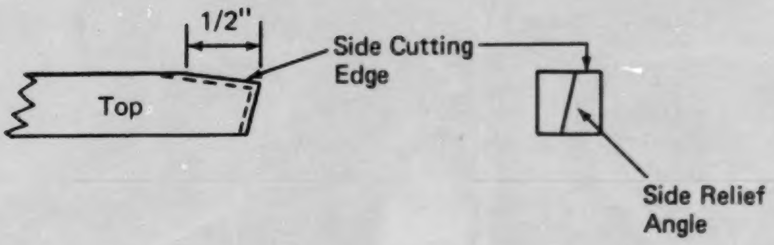
FIGURE 43


6°
Face of Grinding Wheel
Grinding Wheel
Top
End of Cutting Tool
Tool Rest

3. Bring tool into contact with grinding wheel, and grind side cutting edge and side clearance angle at the same time, using side movement and light pressure

4. Continue grinding until cutting edge is about the width of tool (Figure 44)

FIGURE 44

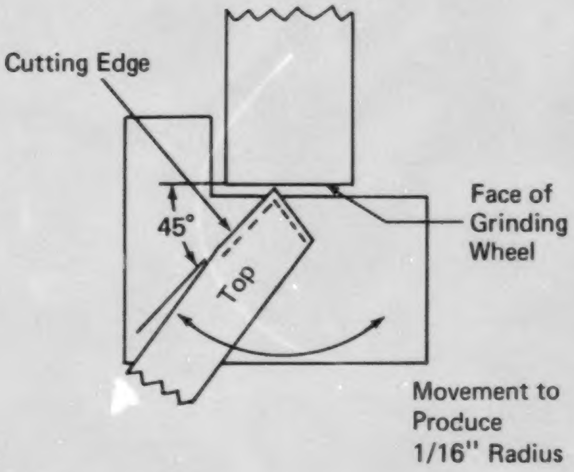

1/2"
Side Cutting Edge
Top
Side Relief Angle

JOB SHEET #1

C. Grind nose radius by holding tool point up about 4° with cutting edge of the tool at a 45° angle to face of grinding wheel; generate a 1/16" radius on the point (Figure 45)

(NOTE: The radius will start at the bottom and come up to the cutting edge.)

FIGURE 45


Cutting Edge
45°
Top
Face of Grinding Wheel
Movement to Produce 1/16" Radius

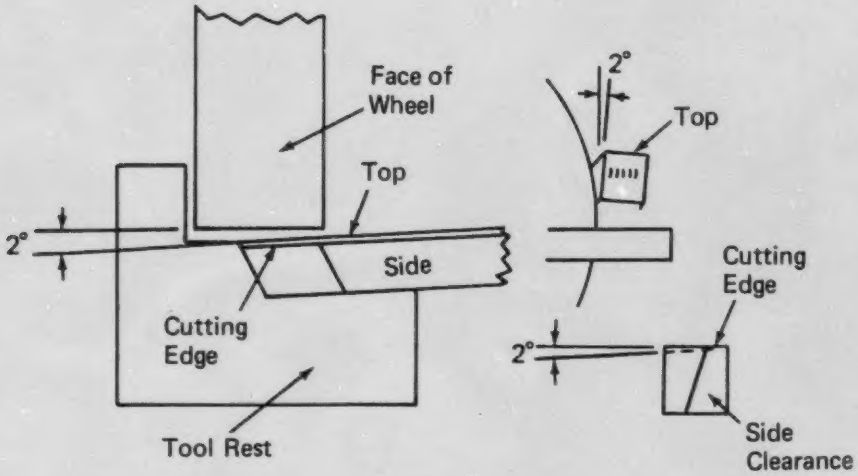
D. Grind side and back rake angles

1. Grind side and back rake angles at the same time by holding top of tool bit parallel to face of grinding wheel so that side cutting-edge angle is horizontal

JOB SHEET #1

2. Tilt nose of cutting tool away from face of wheel about 2°; then tilt cutting edge away from wheel 2° (Figure 46)

FIGURE 46



Face of Wheel
Top
2°
Side
Cutting Edge
Tool Rest
2°
Top
Cutting Edge
2°
Side Clearance

3. Bring bit into contact with face of grinding wheel, and continue to grind side and back rake angles until the ground surface blends with cutting edge

E. Repeat procedure with fine-grit wheel

F. Use protractor and radius gauges to check tool geometry; regrind incorrect surfaces if they can be corrected

G. Hone all cutting edges with oilstone to remove wire edges

H. When you and your instructor are satisfied with your work on the keystock material, repeat procedure with high-speed steel tool bit blank

SHAPERS
UNIT I

JOB SHEET #2--GRIND A FILLET CUTTING TOOL

I. Equipment and materials

- A. Pedestal grinder
- B. Grinding wheel dresser
- C. Goggles
- D. Steel-edged protractor
- E. Radius gauge set
- F. Oilstone
- G. Keystock, 3" long, 5/16" or 3/8" square
- H. High-speed steel tool bit blank to fit toolholder

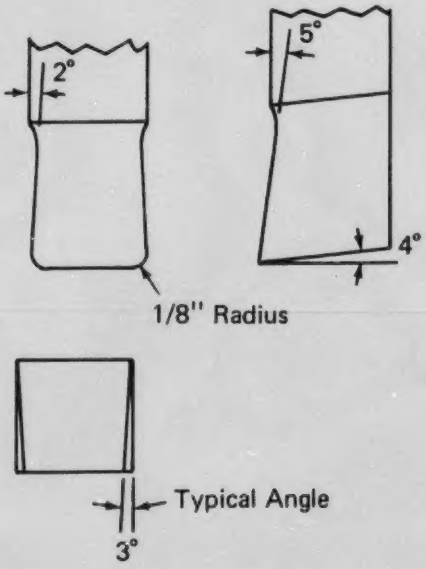
II. Preparation for free-hand grinding

(CAUTION: You must have passed the pedestal grinder safety test before performing this procedure.)

- A. Dress faces of both coarse and fine-grit aluminum oxide grinding wheels
- B. Stop grinder and adjust tool rest and spark breaker

III. Procedure for grinding a fillet cutting tool (Figure 47)

FIGURE 47



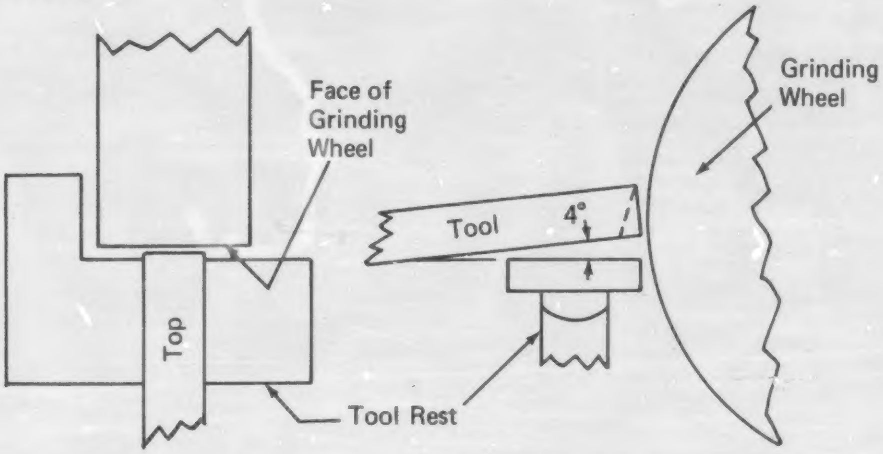
JOB SHEET #2

A. Grind end relief

(NOTE: Use keystock for practice. Rough grind the tool with the coarse wheel, and finish grind with the fine wheel.)

1. Hold tool square with face of wheel; tilt end of tool up about 4° (Figure 48)

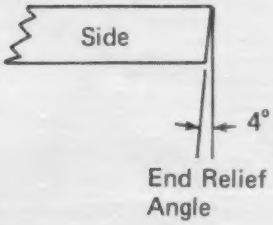
FIGURE 48


Face of Grinding Wheel
Top
Tool Rest
Tool
4°
Grinding Wheel

2. Move tool into wheel and grind until end relief angle reaches top surface (Figure 49)

   (NOTE: Keep the tool cool by frequently dipping it in water; the cutting tool should never be permitted to change colors from heat generated by grinding.)

FIGURE 49

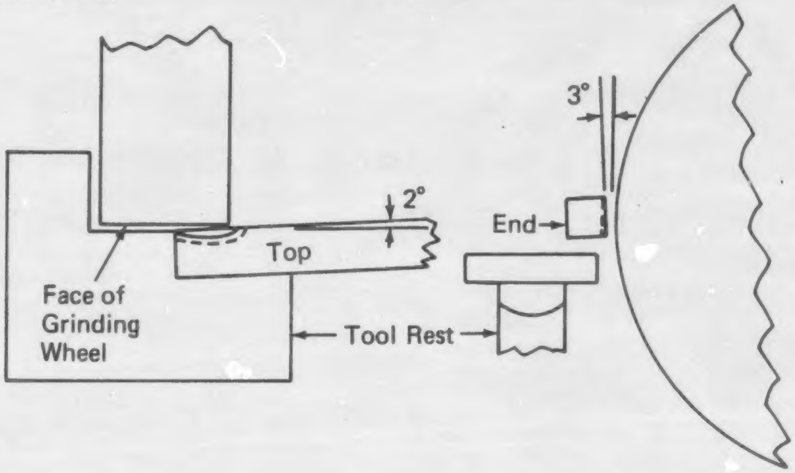

Side
4°
End Relief Angle

JOB SHEET #2

B. Grind side relief and side clearance angles

1. With one side of tool parallel to face of grinding wheel, turn tool point away from grinding wheel about 2° and tilt top surface back from wheel 3° (Figure 50)

FIGURE 50

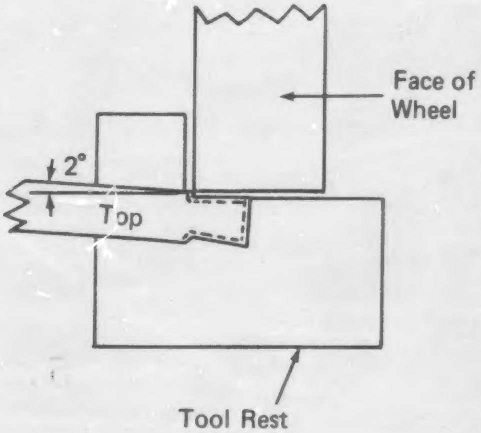

3°
2°
End
Top
Face of Grinding Wheel
Tool Rest

2. Hold tool at these angles and grind side relief and side clearance angles at the same time

3. Continue to grind these angles until side clearance angle reaches top of tool cutting edge

4. Turn tool to grind side relief and side clearance angles on other side (Figure 51)

FIGURE 51


Face of Wheel
2°
Top
Tool Rest

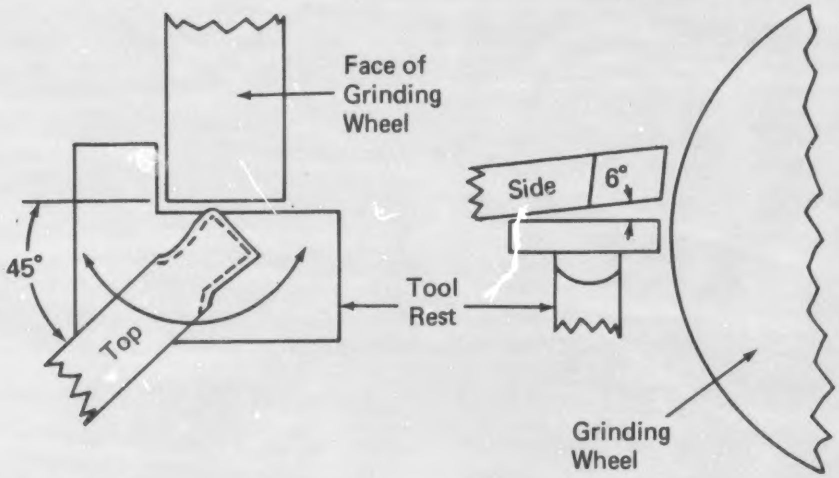
JOB SHEET #2

C. Grind corner radius

1. Hold tool about 45° to wheel and tilt end up about 6°
2. Move tool in a circular motion and grind 1/8" radius on corner (Figure 52)

   (NOTE: The radius should start grinding at the bottom and work its way to the cutting edge.)

FIGURE 52



3. Turn tool to grind 1/8" radius on other corner in the same manner

D. Repeat procedure with fine-grit wheel

E. Use protractor and radius gauge to check geometry of tool bit; regrind incorrect surfaces if they can be corrected

F. Use oilstone to hone cutting edges of tool to remove wire edges

G. When you and your instructor are satisfied with your work on the keystock material, repeat procedure with high-speed steel tool bit blank

SHAPERS
UNIT I

JOB SHEET #3--GRIND A V-SHAPED TOOL

I. Equipment and materials

- A. Pedestal grinder
- B. Grinding wheel dresser
- C. Goggles
- D. Steel-edged protractor
- E. Radius gauge set
- F. Oilstone
- G. Keystock, 3" long, 3/8" or 1/2" square
- H. High-speed steel tool bit blank to fit toolholder

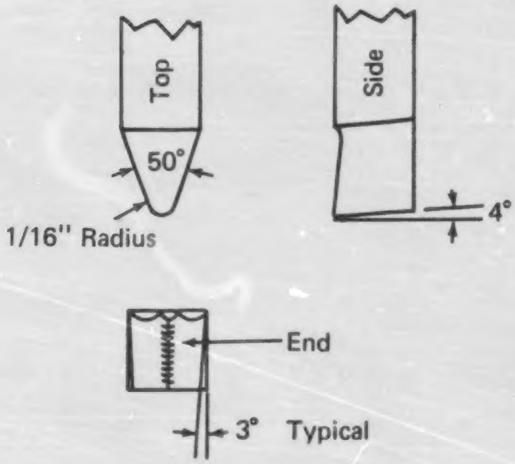
II. Preparation for free-hand grinding

(CAUTION: You must have passed the pedestal grinder safety test before continuing this procedure.)

- A. Dress faces of both coarse and fine-grit aluminum oxide grinding wheels
- B. Stop grinder and adjust tool rest and spark breaker

III. Procedure for grinding a V-shaped tool (Figure 53)

FIGURE 53



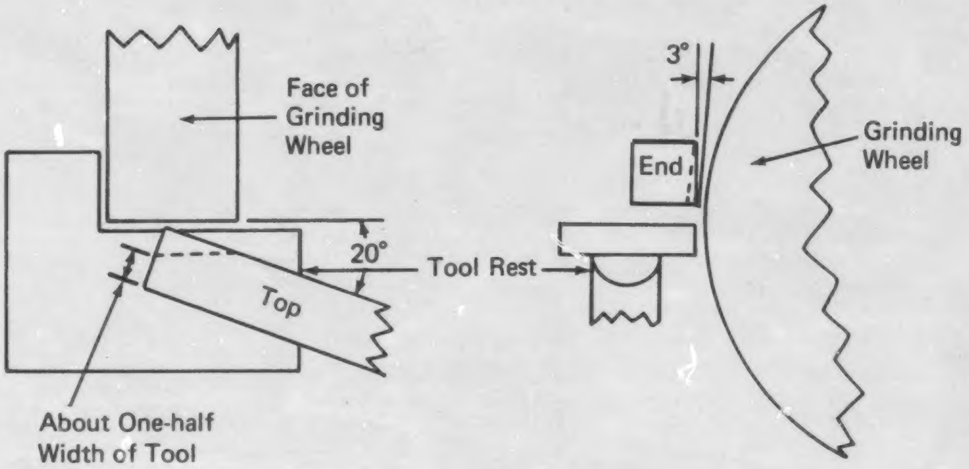
JOB SHEET #3

A. Grind side angle and side relief angle

(NOTE: Use keystock for practice. Rough grind the tool with the coarse wheel, and finish grind with the fine wheel.)

1. Hold one side of tool at about a 20° angle to face of grinding wheel and tilt side away from face about 3° (Figure 54)

FIGURE 54

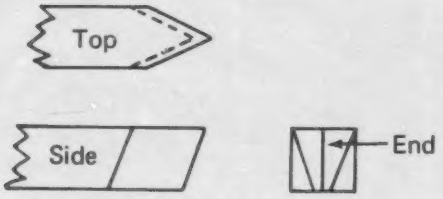

Face of Grinding Wheel
20°
Tool Rest
Top
About One-half Width of Tool
3°
End
Grinding Wheel

2. Move tool into grinding wheel, and grind side angle and side clearance angle at the same time; continue to grind until angle is in the middle

(NOTE: Keep the tool cool by frequently dipping it in water; the cutting tool should never be permitted to change colors from heat generated by grinding.)

3. Turn tool and grind other side angle, producing a point on the tool (Figure 55)

FIGURE 55

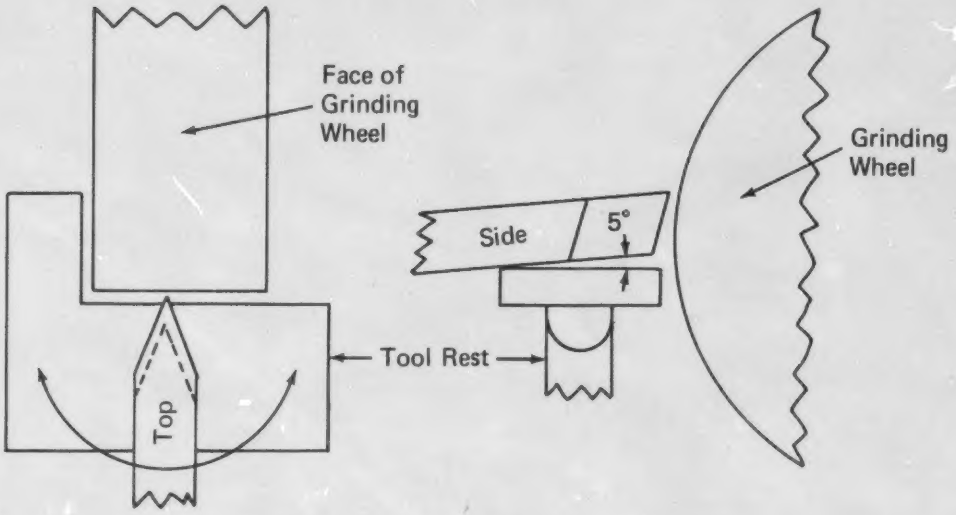

Top
Side
End

JOB SHEET #3

B. Grind nose radius and end clearance angle

1. Hold tool square to face of wheel; tilt end of tool up about 5°
2. Move tool in an arc, grinding nose radius and end clearance angle at the same time (Figure 56)

FIGURE 56


Face of Grinding Wheel
Grinding Wheel
Side
5°
Top
Tool Rest

C. Grind front rake

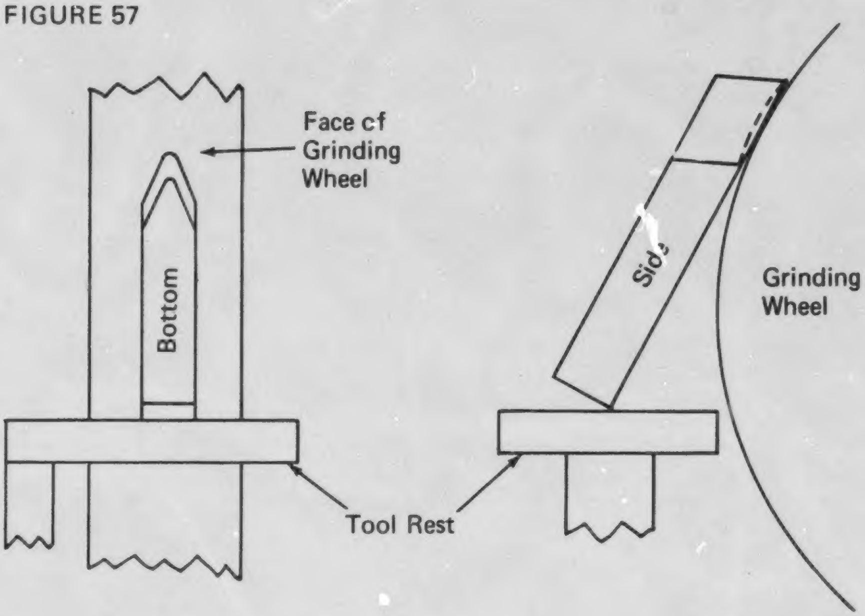
1. Hold tool so that you are looking at the bottom of it with the sharpened end up

JOB SHEET #3

2. Set unsharpened end on tool rest about 1" from face of grinding wheel; tilt nose of tool into face of wheel (Figure 57)

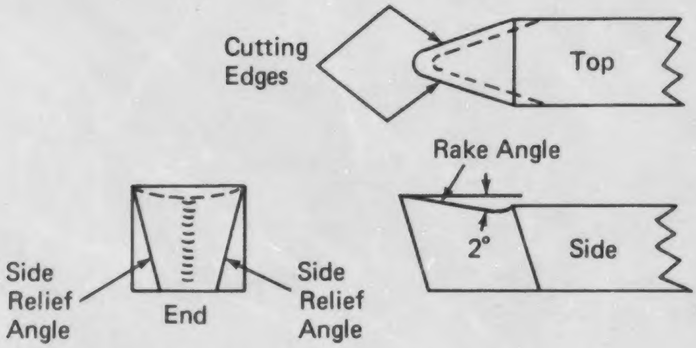
   (NOTE: Depending on the diameter of the grinding wheel, the end that is resting on tool rest may be closer or farther away than the one inch.)

FIGURE 57


Face of Grinding Wheel
Bottom
Side
Grinding Wheel
Tool Rest

3. Continue to grind until the grinding wheel has produced a ground surface on the cutting tool that slopes back about 2° from the point and has even cutting edges (Figure 58)

FIGURE 58


Cutting Edges
Top
Rake Angle
2°
Side
Side Relief Angle
End
Side Relief Angle

JOB SHEET #3

D. Repeat procedure with fine-grit wheel

E. Use protractor and radius gauge to check geometry of tool bit; regrind incorrect surfaces if they can be corrected

F. Use oilstone to hone cutting edges of tool to remove wire edges

G. When you and your instructor are satisfied with your work on the keystock material, repeat procedure with high-speed steel tool bit blank

SHAPERS
UNIT I

JOB SHEET #4--ALIGN VISE SQUARE AND FLAT

I. Equipment and materials

A. Shaper with swivel-base vise and toolholder

B. Steel square

C. Dial indicator with attachments (plunger back)

D. Soft-faced mallet

E. Matched set of parallels, 3/4" x 2" x 8"

F. Clean cloth

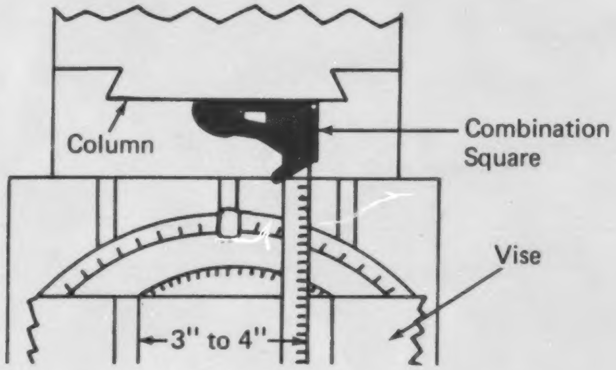
II. Procedure

A. Open vise jaws 3" to 4"

B. Set vise so that jaws are parallel to ram

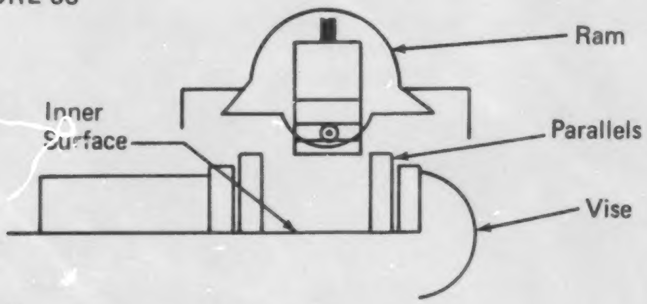
C. Use steel square to square vise to column (Figure 59)

FIGURE 59


Column
Combination Square
Vise
3" to 4"

D. Secure hold-down bolts (Figure 60)

FIGURE 60


Ram
Inner Surface
Parallels
Vise

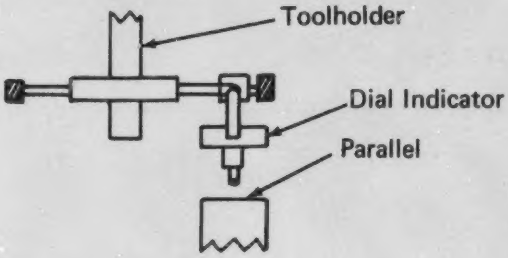
JOB SHEET #4

E. Wipe inner surface of vise and check for burrs

F. Place parallels in vise on an 8" side with one parallel along each jaw

G. Mount indicator to toolholder so that plunger is down (Figure 61)

FIGURE 61

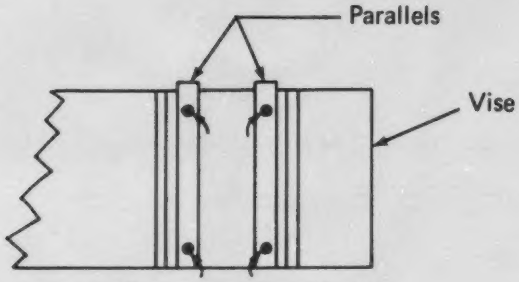


H. Lower work head until plunger of indicator makes contact near end of one parallel; load indicator plunger about 0.010", and then zero indicator by turning dial

I. Move table and ram to take readings at four points on parallels (Figure 62)

(CAUTION: Use hand power to move ram and table.)

FIGURE 62



Take Indicator Readings at Arrows

J. If all points do not read zero, check for the following

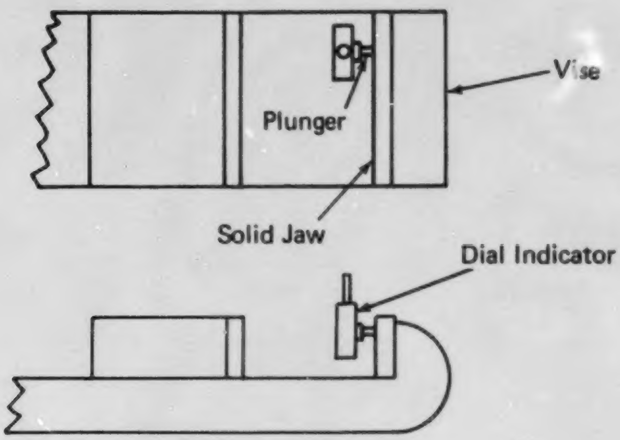
1. Gibs on cross slide need adjustment (adjust gibs)
2. Parallels not matched or not parallel (get other parallels)
3. Dirt between table and vise base (clean and remount)
4. Vise mounted on a universal table that is not square with ram (remove vise and indicate table)
5. Vise base not parallel to bottom of vise work area (shim between base of vise and table)

JOB SHEET #4

K. When points all read zero and vise is flat, continue procedure to align solid jaw parallel to ram

L. Align solid jaw parallel to stroke of ram by turning indicator so that plunger touches solid jaw near one end; place load of about 0.015" on indicator and zero it (Figure 63)

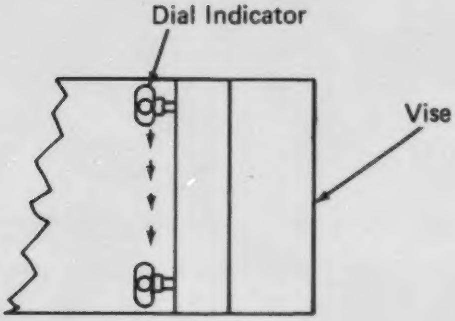
FIGURE 63


Vise
Plunger
Solid Jaw
Dial Indicator

M. Move ram to take reading near other end of vise jaw (Figure 64)

(CAUTION: Move ram with hand power only.)

FIGURE 64


Dial Indicator
Vise

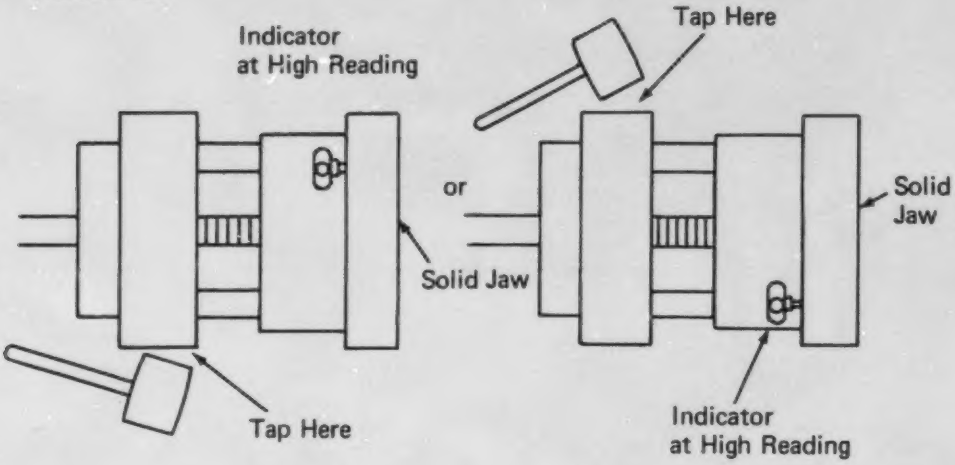
N. Compare readings and note difference

JOB SHEET #4

O. Move indicator to end that shows the greater load reading; tap vise with soft-faced mallet on end of movable jaw opposite indicator (Figure 65)

(CAUTION: Always adjust the vise away from the indicator.)

FIGURE 65


Indicator
at High Reading
Tap Here
or
Solid Jaw
Solid
Jaw
Tap Here
Indicator
at High Reading

P. Tap vise lightly until indicator needle moves one-half the difference between the first two readings; zero indicator

Q. Move ram by hand to indicate near other end of jaw; if dial reads zero, no other adjustment is necessary; if not, repeat procedure until you obtain a zero reading at each location

R. Tighten clamping nuts

S. Recheck alignment and adjust as necessary

(NOTE: To align the vise perpendicular to the stroke of the ram, use a variation of this procedure with the vise turned perpendicular to the ram. Indicate against the solid jaw but move the table to change indicator locations.)

SHAPERS
UNIT I

JOB SHEET #5--SET LENGTH OF STROKE AND POSITION RAM

I. Equipment and materials

A. Standard crank shaper

B. Block of steel, SAE 1045, 2" x 2" x 6"

C. Left- or right-hand cutting tool and toolholder

D. Wrenches to fit tool post screw

II. Procedure for setting length of stroke

(NOTE: Power should be off.)

A. Put crank on shaft for setting length of stroke

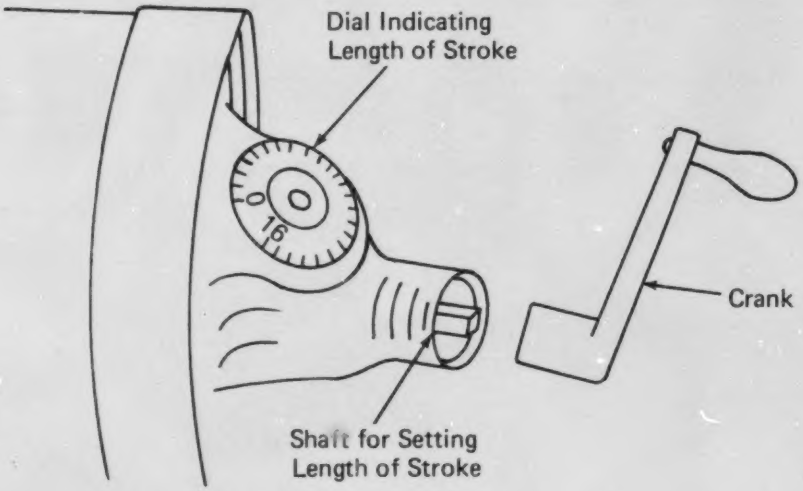
(NOTE: The length of stroke is set 1" longer than the overall length of the cut.)

B. Turn crank so that dial indicating the length of stroke is set to 7" (Figure 66)

(CAUTION: Crank must be removed before operating shaper.)

(NOTE: If the shaper does not have an automatic clamping device, loosen clamping nut that locks adjusting shaft before turning shaft to adjust length of stroke. Tighten after the setting has been made.)

FIGURE 66


Dial Indicating Length of Stroke
0
16
Crank
Shaft for Setting Length of Stroke

JOB SHEET #5

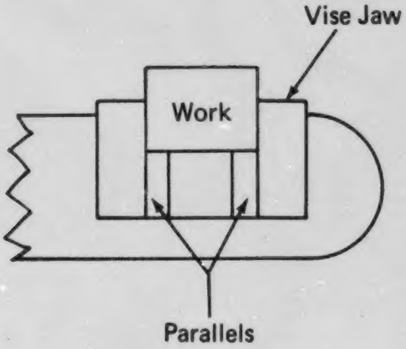
III. Procedure for positioning ram

A. Put work in vise so that top surface is above vise jaws (Figure 67)

B. Mount cutter in toolholder positioned to make a flat surface cut

(NOTE: Positioning of ram is always done after tool is mounted and work is in place and secured.)

FIGURE 67



C. Crank shaper-head handle so that tool clears top surface of work about 1/4"

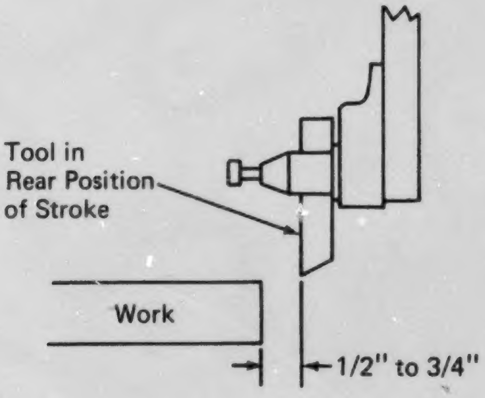
D. Move ram to extreme rear position, either by power or by hand

E. Loosen ram positioning lock located on top of ram

F. Put crank on ram positioning shaft; move ram forward or backward, depending on the location of the work, so that tool is 1/2" to 3/4" from rear end of work (Figure 68)

(NOTE: Tool should never be closer to work than 1/2" at beginning of stroke.)

FIGURE 68



JOB SHEET #5

G. Tighten ram positioning lock

H. Remove crank from ram positioning shaft

I. Turn power on and check position of tool to work for proper clearance at both ends of work

(NOTE: The clearance at each end is to allow the clapper to pick up and to reseat before ram makes the next stroke.)

SHAPERS
UNIT I

JOB SHEET #6--SET SPEEDS AND FEEDS

I. Equipment--Standard crank shaper

II. Procedure for setting speed (strokes per minute)

(NOTE: Power should be off.)

A. Calculate number of strokes required to make a 7" stroke if cutting cast iron with a carbide cutting tool

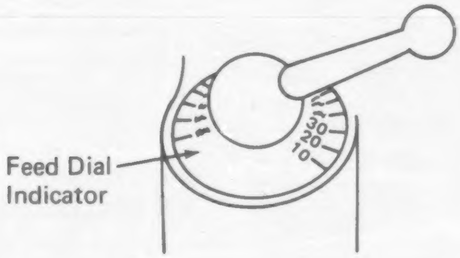
B. Use back gear lever and gearshaft lever to set the required number of strokes

III. Procedure for setting feed (movement of table per stroke)

A. Determine feed range on correct feed and speed chart

B. Turn cross-feed lever to desired setting (Figure 69)

FIGURE 69



(NOTE: Numbers represent movement per stroke in thousandths.)

EXAMPLE: 10 = 0.010
20 = 0.020

C. Turn on power and observe movement of ram and table

(NOTE: Table movement should be completed before ram has moved forward far enough to allow the tool to contact the work. If table is still moving over when cutting, a wavy cut will result and tool will possibly break.)

D. Adjust feed setting as necessary

SHAPERS
UNIT I

JOB SHEET #7-CUT INTERNAL AND EXTERNAL KEYWAYS

I. Equipment and materials

A. Shaper

B. Straight toolholder

C. Extension bar and holder

D. Shaper cutting tools for rough and finish cuts

E. Cutting oil and brush

F. Paper pad

G. Combination square with 12" blade

H. Steel rule, 6"

I. Parallel

J. Machine-steel bar, 3" long, 1 1/2" diameter

K. Square aluminum plate, 3" x 3" x 1", with 2" hole in center

II. Procedure for cutting external keyways

(NOTE: This is the procedure for keyways in the full length of the work. Check with your instructor on the steps required for keyways that run only part of the length of the work.)

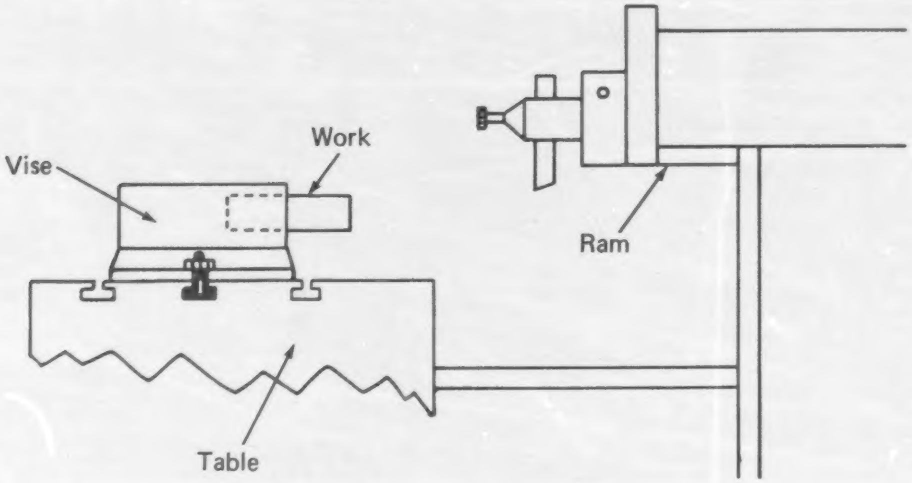
A. Mark location of 1/4" keyway on steel bar

B. Align vise parallel to ram

JOB SHEET #7

C. Align work in vise so that about 1" of work extends from vise toward column (Figure 70)

FIGURE 70

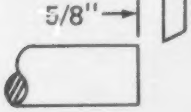


D. Set length of stroke to 4"

E. Mount roughing tool in toolholder and attach to shaper

F. Position ram so that shaper starts its forward movement when tool is about 5/8" from end of bar; be sure that the stroke allows adequate clearance (Figure 71)

FIGURE 71



G. Set speed (number of strokes per minute)

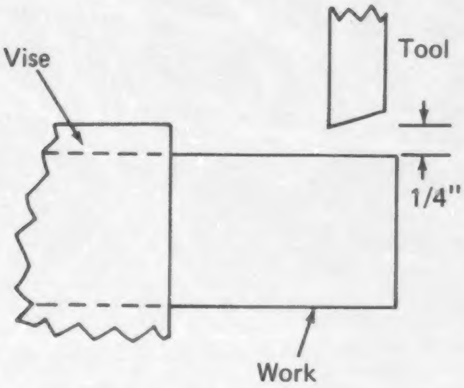
(NOTE: Use chart to calculate.)

H. Align tool on center line of round bar

JOB SHEET #7

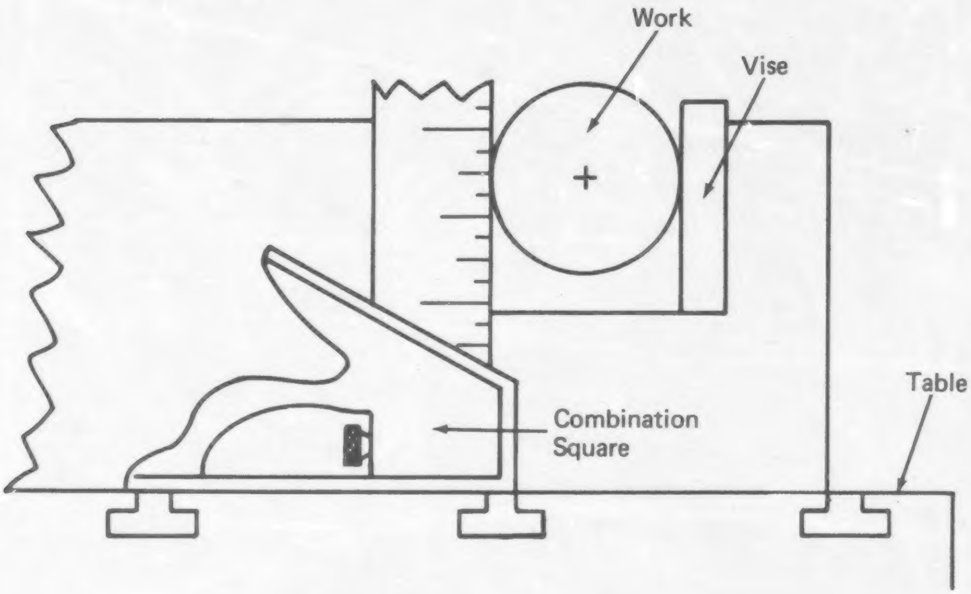
1. Move the ram forward by hand until tool is about 1/4" above portion of work that protrudes from vise (Figure 72)

FIGURE 72


Vise
Tool
1/4"
Work

2. Set base of square on table with edge of blade in contact with bar (Figure 73)

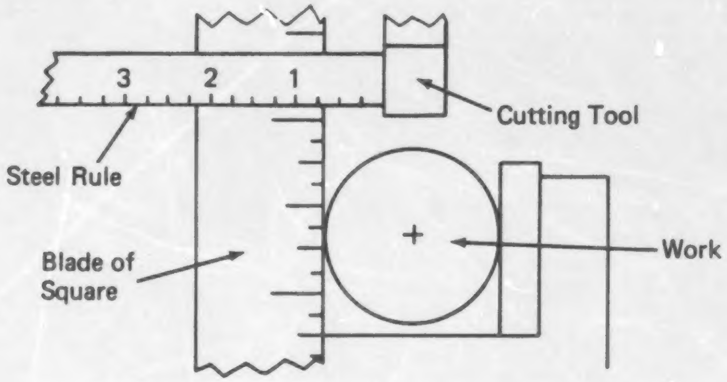
FIGURE 73


Work
Vise
Table
Combination Square

JOB SHEET #7

3. Hold square in place with one hand and hold steel rule against side of square blade; slide rule so that its end touches cutting tool (Figure 74)

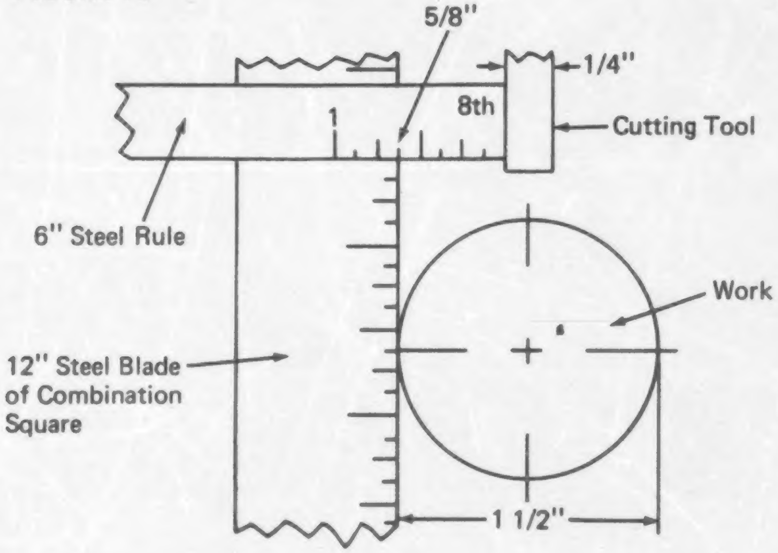
FIGURE 74


3
2
1
Cutting Tool
Steel Rule
Blade of Square
Work

4. Note distance between tool and edge of square blade; move table right or left until that distance is one-half the diameter of bar less one-half the width of cutting tool (Figure 75)

   EXAMPLE: The reading from steel square blade to tool should be a 5/8" reading on steel rule.

FIGURE 75

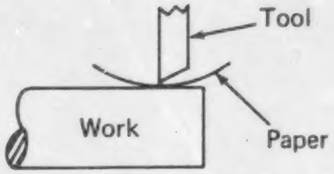

5/8"
1/4"
1
8th
Cutting Tool
6" Steel Rule
Work
12" Steel Blade of Combination Square
1 1/2"

JOB SHEET #7

I. Place a piece of paper between tool and work; bring cutter down until it rests on paper (Figure 76)

(NOTE: The paper will leave the tool 0.002" to 0.003" above the surface of the work.)

FIGURE 76

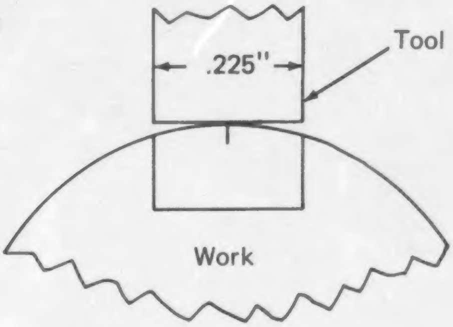


J. Remove paper and start machine; feed tool down manually until it marks work

K. Stop machine when it reaches end of its return stroke, and check location of cut; adjust if necessary (Figure 77)

(NOTE: When stopping a shaper, wait until the ram is at the end of the return stroke.)

FIGURE 77



L. Apply cutting oil

M. Start machine and feed toolhead down until cutting tool has cut the width; stop machine

N. Check position of tool to make sure that it is where you have marked it; adjust, if necessary, and then zero the graduated collar on toolhead

O. Start machine and cut keyway by feeding tool down 0.005" per stroke to a depth of 0.115" to 0.120"; apply cutting oil as required

P. Stop machine; put finishing tool in toolholder and repeat steps F through M as necessary

JOB SHEET #7

Q. Cut key to proper depth at a feed rate of 0.005" per stroke, applying cutting oil as necessary

(NOTE: The depth of a keyway is normally half the height of the key.)

IV. Procedure for cutting internal keyways

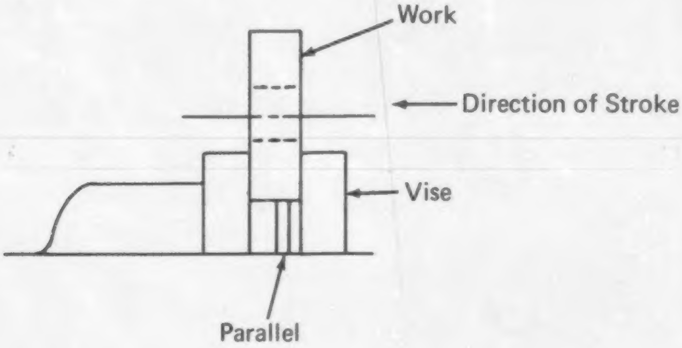
A. Align vise perpendicular to stroke of ram

B. Set length of stroke at 2"

C. Rest aluminum plate on a parallel and secure it in vise so that hole is aligned with stroke of ram and above vise jaws (Figure 78)

(NOTE: In this case it is not possible to cut toward the solid jaw of vise.)

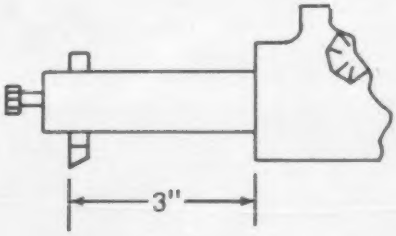
FIGURE 78



D. Mount extension bar in holder so that bar protrudes about 3"; mount in toolhead (Figure 79)

(NOTE: Always keep length of bar as short as possible to eliminate spring.)

FIGURE 79

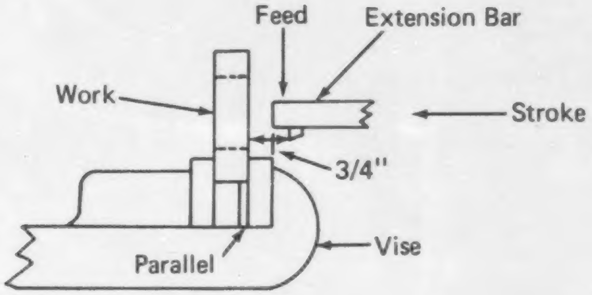


E. Using the steel rule, center cutter to hole

JOB SHEET #7

F. Position ram so that shaper starts its forward movement with cutter about 3/4" from end of work; be sure that stroke allows sufficient clearance (Figure 80)

FIGURE 80



G. Set number of strokes

H. Start machine and feed toolhead down manually until tool marks work

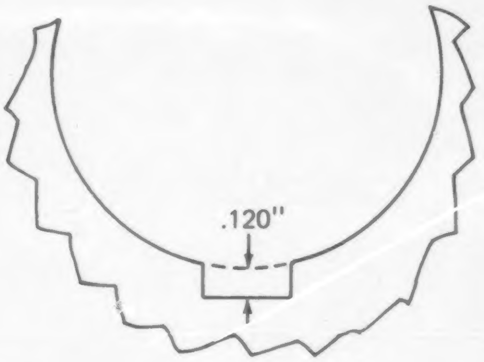
I. Stop machine and check position of tool to location of keyway; adjust if necessary

J. Zero graduated collar on toolhead

K. Apply cutting oil

L. Start machine and feed toolhead down 0.005", with each stroke cut to a depth of 0.120"; apply cutting oil as required (Figure 81)

FIGURE 81



JOB SHEET #7

M. Stop machine and remove roughing tool; mount finishing tool and repeat steps E through K as necessary

N. Start machine and cut keyway to depth, feeding 0.005" with each stroke and applying cutting oil as required

O. Stop machine, put away all tools, and clean machine and work area

SHAPERS
UNIT I

JOB SHEET #8--CUT A PART SQUARE AND FLAT

I. Equipment and materials

   A. Shaper with vise

   B. Parallels, 3/8" x 3/4" x 8"

   C. Soft metal bar, 1/2" diameter, 5" length

   D. Micrometer, 2" to 3"

   E. Left-hand roughing tool (HSS)

   F. Left-hand finishing tool (HSS)

   G. Blueprint of V-block (Job Sheet #10)

   H. Piece of 1095 steel; 2 1/4" x 2 1/4" x 5"

   I. Soft-faced mallet

   J. Square set or bevel protractor

   K. Left- or right-side roughing tool

   L. Cutting oil and brush

   M. File

II. Procedure to cut sides of part square and flat

   A. Align vise flat and parallel to stroke of ram; clean vise

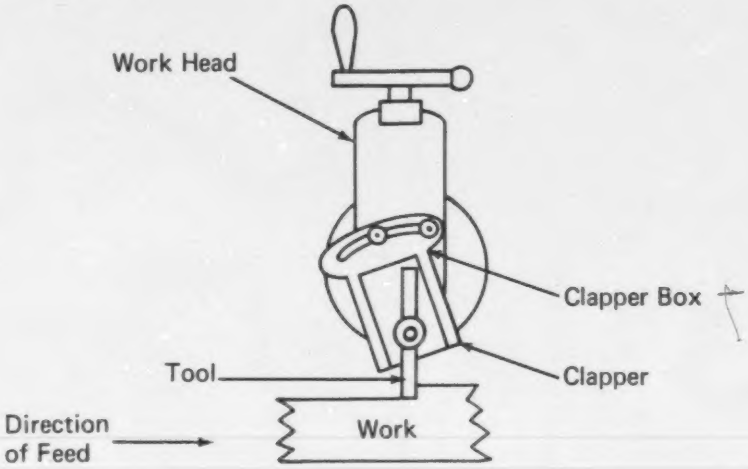
   B. Mount left-hand roughing tool in toolholder

JOB SHEET #8

C. Turn apron to set clapper box 10° to work against direction of table feed; clamp tool in tool post so that it is perpendicular to work (Figure 82)

(NOTE: The tool is set in this manner so that if the apron slips, the tool will swing clear of the work.)

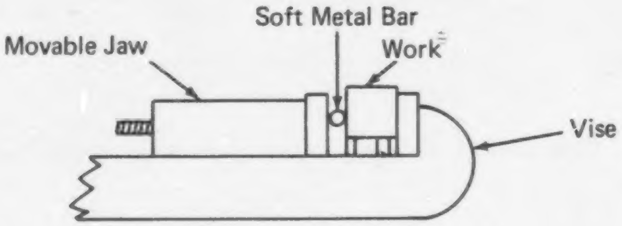
FIGURE 82


Work Head
Clapper Box
Clapper
Tool
Direction of Feed
Work

D. Mount block of steel in vise on parallels with 5" sides held by vise and surface to be machined at least 1/4" above jaws; use soft metal bar between work and movable jaw, positioning bar in middle of clamped portion of the work

E. Seat work squarely on parallels with soft-faced mallet (Figure 83)

FIGURE 83


Soft Metal Bar
Movable Jaw
Work
Vise

F. Set length of stroke for 6"

JOB SHEET #8

G. Position ram tool 5/8" from end of work

H. Calculate number of strokes, set speed, and set feed at 0.010" per stroke

I. Turn down-feed handle to bring tool about 0.015" below top surface

J. Engage table feed

K. Apply cutting oil, and cut first side flat

L. Remove part from vise and deburr

M. Repeat steps D through I with cut side of work against solid jaw of vise

N. Cut second side flat; remove part and deburr

O. Place work in vise so that first side is against solid jaw and second side is on parallels; use soft metal as before

P. Repeat steps D through I

Q. Continue cutting until work is approximately 2.030"; remove and deburr

R. Place work in vise with remaining side up

(NOTE: With three machined sides, the soft metal bar is no longer necessary.)

S. Repeat steps D through I

T. Continue cutting until work is approximately 2.030"; remove and deburr

U. Replace roughing tool with finishing tool

V. Position ram

W. Set feed at 0.005" per stroke

X. Turn down-feed handle to bring tool about 0.005" below surface

Y. Repeat cutting procedure with finishing tool, machining block to 2.020" x 2.020"

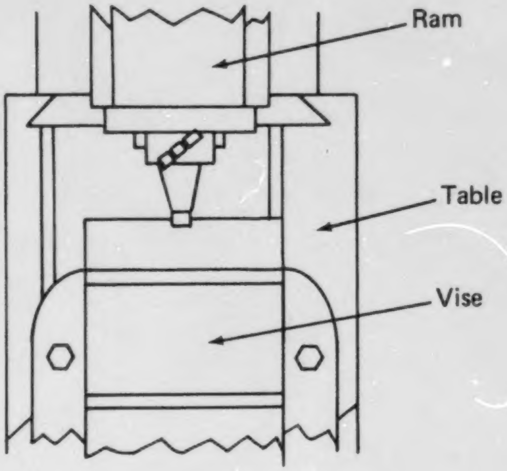
(NOTE: If time permits, continue procedure to cut ends square and flat. Otherwise, clean machine, put away tools in proper place, and set aside to be used in other job sheets.)

JOB SHEET #8

III. Procedure to cut ends of part square and flat

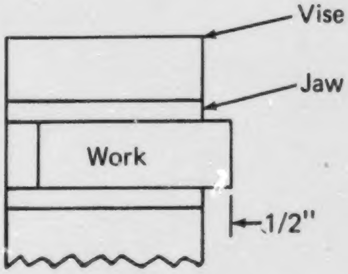
A. Align vise perpendicular to ram (Figure 84)

FIGURE 84


Ram
Table
Vise

B. Put part in vise so that end protrudes past end of jaws about 1/2"; seat part in vise (Figure 85)

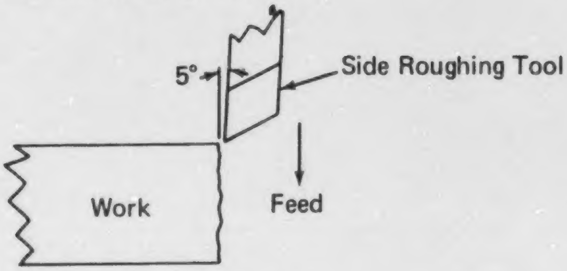
FIGURE 85


Vise
Jaw
Work
1/2"

C. Mount proper size side-roughing tool in tool post; swivel tool about 5° so that it will have clearance (Figure 86)

(NOTE: The toolhead *must* be set on zero.)

FIGURE 86


5°
Side Roughing Tool
Feed
Work

JOB SHEET #8

D. Set length of stroke at 3.250" and positon ram

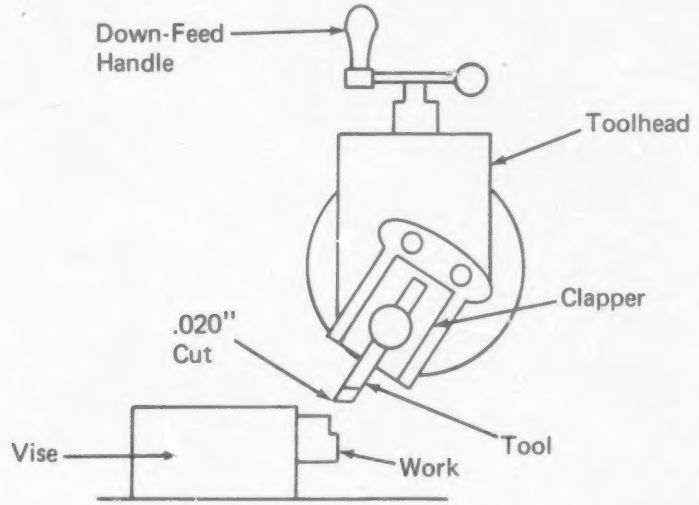
E. Calculate and set speed

F. Move work toward tool by turning cross-feed shaft until you have a cut of about 0.020"

G. Apply cutting oil and use as necessary during machining

H. Start ram and turn down-feed handle on toolhead to about 0.020" during return portion of each stroke (Figure 87)

FIGURE 87



I. If end did not clean up smoothly, crank work head up and make another cut of 0.020"

(NOTE: If desired, use power feed to move the table up.)

J. Turn work end for end and cut other end smooth

K. Deburr and check ends for squareness

L. If end is more than 2° out of square, adjust machine and recut

M. Clean machine and area, and put away all tools

SHAPERS
UNIT I

JOB SHEET #9--CUT AN ANGULAR SURFACE

I. Equipment and materials

A. Shaper with vise

B. Parallels, 3/8" x 3/4" x 8"

C. Cutting fluid with brush

D. Round-nose roughing tool

E. Blueprint of V-block (Job Sheet #10)

F. Steel part from previous job sheets

G. Combination square set with scriber

H. Layout fluid

I. Right- and left-hand side finishing tools

(NOTE: Square-nose tool may be used.)

II. Procedure

A. Paint ends and sides of part with layout fluid and allow to dry

(CAUTION: Use layout fluid in a well-ventilated area only. Avoid getting fluid on your clothing as the stain will not wash out.)

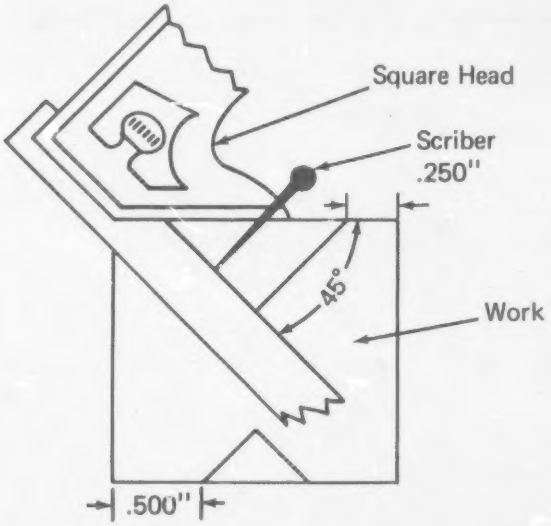
B. Use combination square to lay out lines 0.250" from edge on one side of part; on the opposite side, lay out lines 0.500" from edge

JOB SHEET #9

C. Use 45° angle of square head to lay out 90° angles on each painted end of the work (Figure 88)

(NOTE: The sides of the angles should touch the 0.250" and 0.500" lines.)

FIGURE 88



D. Align vise parallel to ram

E. Seat work in vise on parallels with long sides aligned to stroke of ram and laid-out surface up

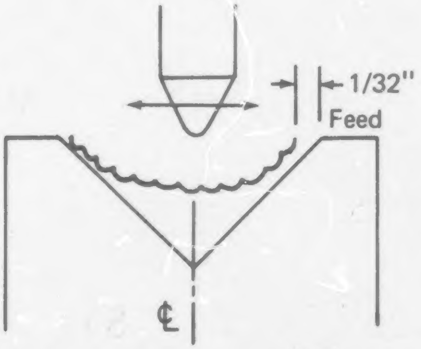
F. Mount round-nose roughing tool on tool post

G. Applying cutting fluid as necessary during cutting, feed tool down and use power feed or hand cross feed to move tool right and left

H. Use layout lines as reference lines (Figure 89)

(NOTE: Do not try to cut exactly to the lines; stay about 1/32" from lines.)

FIGURE 89



JOB SHEET #9

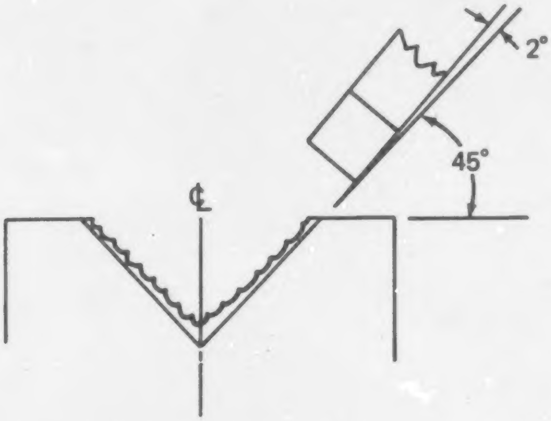
I. Rough out V-shaped area

J. Stop shaper; remove round-point tool and insert left-hand finishing tool or square-nose cutter

K. Set toolhead 45° to right

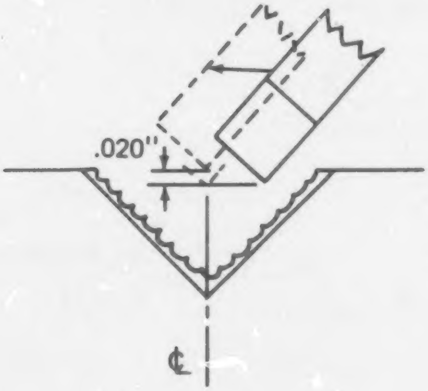
L. Set toolholder so that tool has about 2° clearance (Figure 90)

FIGURE 90



M. Feed tool toward center of V, then feed it down about 0.020" below top surface (Figure 91)

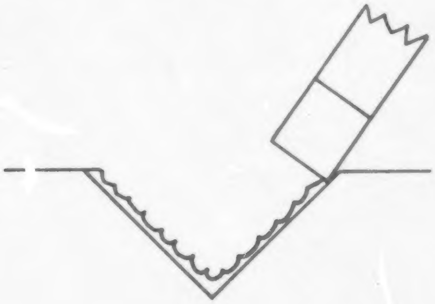
FIGURE 91



JOB SHEET #9

N. Start shaper and feed work toward cutter until tool is cutting on scribed line; apply cutting fluid as necessary during cutting (Figure 92)

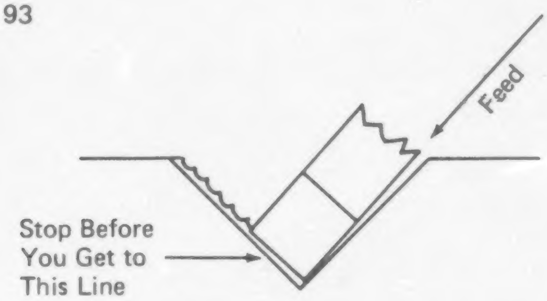
FIGURE 92



O. Using toolhead feed handle, feed work at about 0.020" per stroke at 45° angle until tool nears scribed line; apply cutting oil as required

(CAUTION: Do not feed into the layout line on the other side. See Figure 93.)

FIGURE 93



P. Stop machine and raise toolhead

Q. Loosen toolhead bolts, swivel toolhead to 45° on left side, and secure bolts

R. Change tool to right-hand finishing tool if necessary

S. Repeat steps L through P for other side of V

T. Stop shaper, turn part over, and rough and finish cut other V

U. Stop machine, remove work from vise, and deburr

V. Put away all tools, and clean up machine and work area

SHAPERS
UNIT I

JOB SHEET #10--CUT SLOTS AND GROOVES

I. Equipment and materials

   A. Shaper with vise

   B. Parallels, 3/8" x 3/4" x 8"

   C. Depth micrometer set

   D. Steel rule, 6"

   E. Slotting tool, 3/8" wide

   F. Blueprint of V-block (included at end of job sheet)

   G. Steel part from previous job sheets

   H. Cutting oil and brush

   I. Paper

   J. Grooving tool, 1/8" radius

   (NOTE: You will be cutting two slots. Use each of the following procedures to do one of the slots.)

II. Procedure to cut slot using depth micrometer

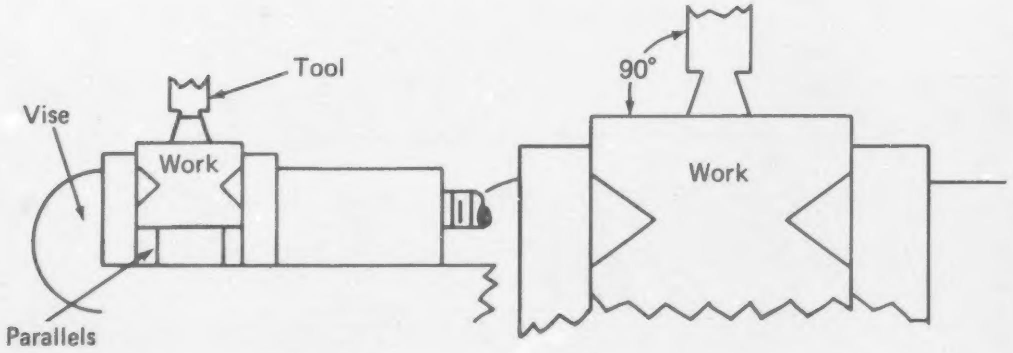
   A. Align vise parallel to stroke of ram

   B. Seat work in vise on parallels with long sides aligned with stroke

   C. Mount tool and holder in tool post

   D. Square tool to work, allowing about 1/8" clearance (Figure 94)

   FIGURE 94



JOB SHEET #10

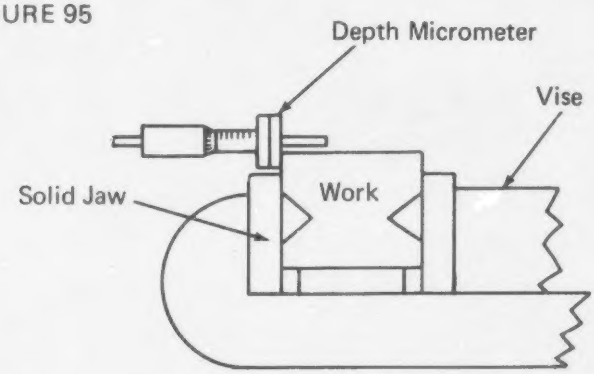
E. Set length of stroke

F. Set speed, and position ram

G. Set depth micrometer on 0.812"

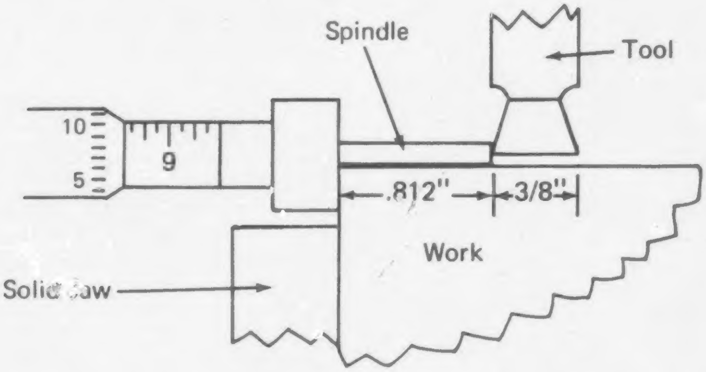
H. With one hand, hold depth micrometer to edge of work that is against solid jaw of vise (Figure 95)

FIGURE 95


Depth Micrometer
Vise
Solid Jaw
Work

I. With other hand, manually move cross feed until side of tool touches depth micrometer spindle (Figure 96)

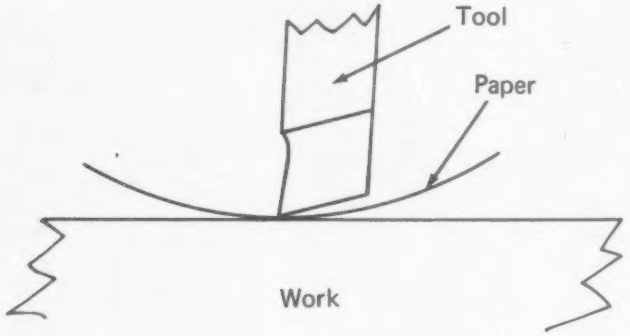
FIGURE 96


Spindle
Tool
10
5
9
.812"
3/8"
Work
Solid Jaw

JOB SHEET #10

J. Lay a slip of paper between tool and work; feed tool down until you can feel with the paper a drag between bottom of tool and work (Figure 97)

FIGURE 97



K. Zero graduated collar on down-feed screw and remove paper

L. Turn on shaper

M. Turn down-feed handle until surface of work is cut

N. Stop ram and check location of slot with steel rule

(NOTE: Adjust cross feed if necessary.)

O. Apply cutting oil as necessary during cutting, and cut slot 0.250" deep by turning down-feed handle 0.015" to 0.020" at end of each return stroke

P. Stop ram and turn down-feed handle up 0.300"

Q. Remove part from vise

III. Procedure for cutting slot using shaper feed dials

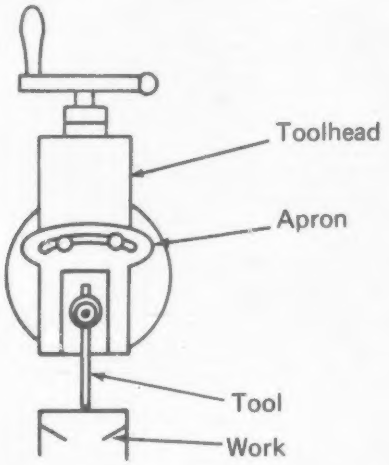
A. Seat part in vise

B. Seat part on parallels in vise with long sides aligned with stroke and with side opposite slotted side up

JOB SHEET #10

C. Mount tool and holder in tool post (Figure 98)

FIGURE 98



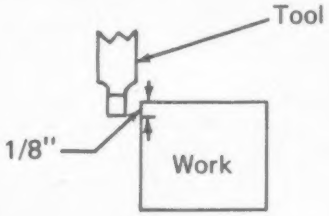
D. Square tool to work, allowing about 1/8" clearance

E. Set length of stroke

F. Set speed, and position ram

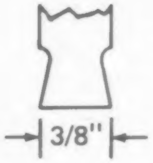
G. Move table so that work is to right of tool; crank toolhead down until tool is about 1/8" below top surface of part (Figure 99)

FIGURE 99



H. Measure width of cutting tool with 0" to 1" micrometer (Figure 100)

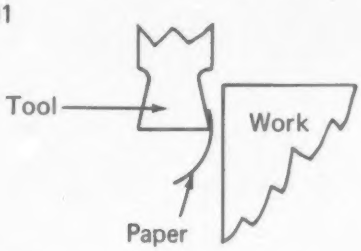
FIGURE 100



JOB SHEET #10

I. Place a piece of paper between cutting tool and part; move table toward tool until tool touches paper (Figure 101)

FIGURE 101

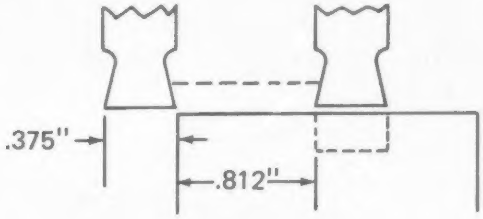


J. Raise toolhead until tool is just above work; remove paper

K. Zero graduated collar on cross feed

L. Crank cross feed toward center of work 0.812" plus the thickness of tool (Figure 102)

FIGURE 102



M. Place piece of paper between work and tool; turn cross slide handle down until tool contacts paper

N. Zero graduated collar and remove paper

O. Apply cutting oil as necessary during cutting, and feed tool down 0.015" to 0.020" at end of each return stroke

P. Continue feeding tool down until a depth of 0.250" is reached

Q. Stop ram and raise tool 0.300"

IV. Procedure for cutting groove

A. With vise aligned parallel to stroke of ram, seat work in vise with long sides aligned with stroke and one of the machined V's up

B. Mount grooving tool in holder and mount holder in tool post

C. Square tool to work

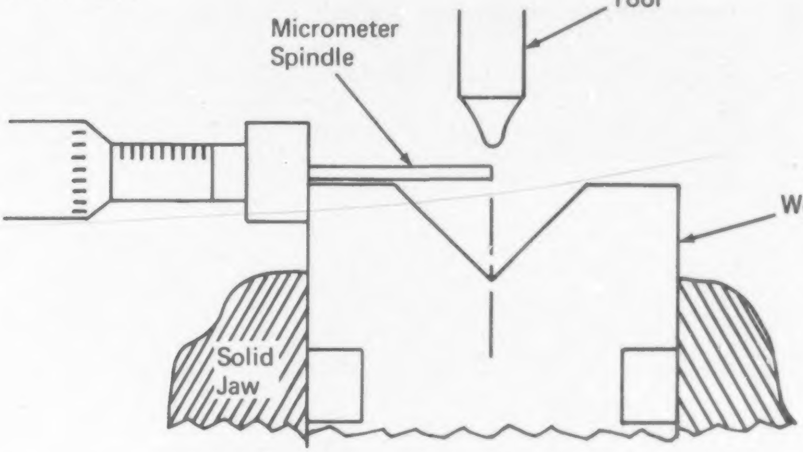
D. Set length of stroke

JOB SHEET #10

E. Set speed and position ram

F. Use depth micrometer to center point of tool over center of V: first measure distance from side of work to center of V, and then position point of tool at that distance (Figure 103)

FIGURE 103



G. Use down-feed handle to lower tool into V

H. Place piece of paper along one side of V and lower tool to paper; zero graduated collar on down-feed screw

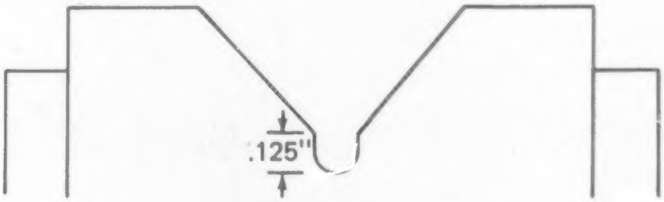
I. Remove paper and turn on shaper

J. Turn down-feed handle until surface of work is cut, and allow ram to travel through one stroke

K. Stop ram and check groove; adjust if necessary

L. Apply cutting oil as necessary during cutting, and cut groove 0.125" deep by turning down-feed handle 0.015" to 0.020" at end of each return stroke (Figure 104)

FIGURE 104



M. Stop ram and raise down-feed handle up 0.300"

JOB SHEET #10

N. Remove part from vise; turn it over to cut groove in other V, making sure that side clamped by solid jaw is the same as was used in cutting first groove

O. Feed tool down to a zero reading on down-feed graduated collar

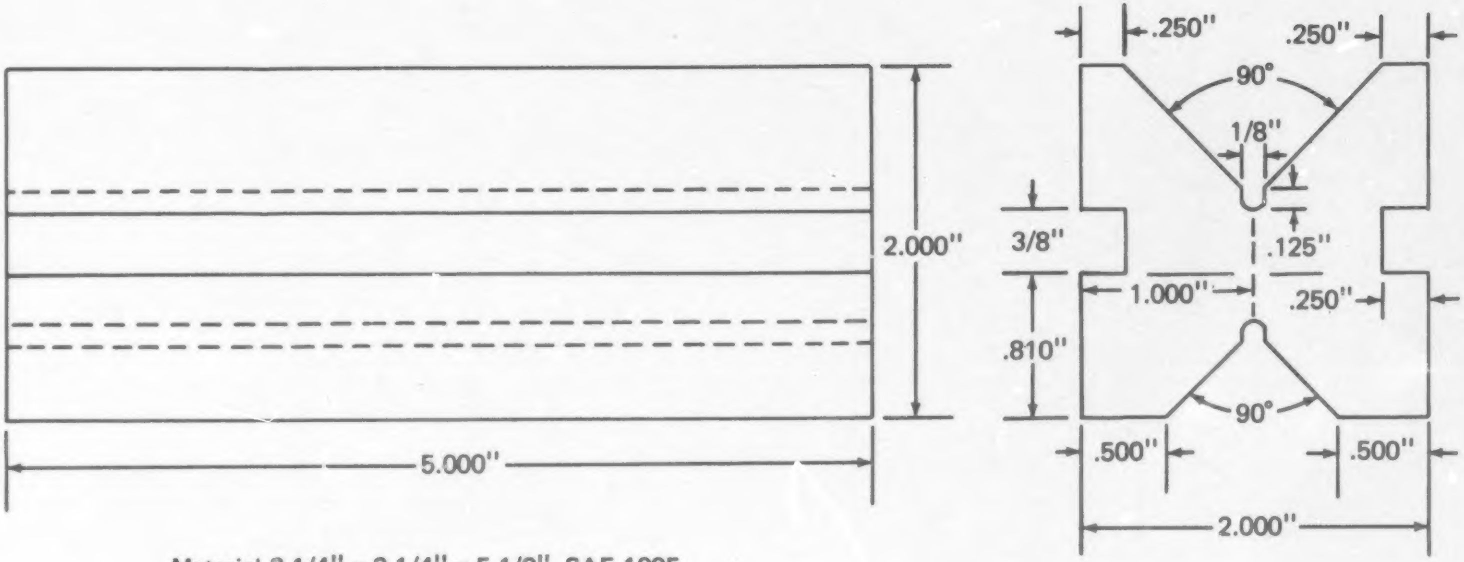
P. Repeat steps J through M

Q. Turn off shaper, remove part, and deburr slots and grooves

R. Clean machine and work area and put away all tools

JOB SHEET #10

Blueprint of a V-Block (Part 1)


2.000"
5.000"
.250"
.250"
90°
1/8"
3/8"
.125"
1.000"
.250"
.810"
90°
.500"
.500"
2.000"

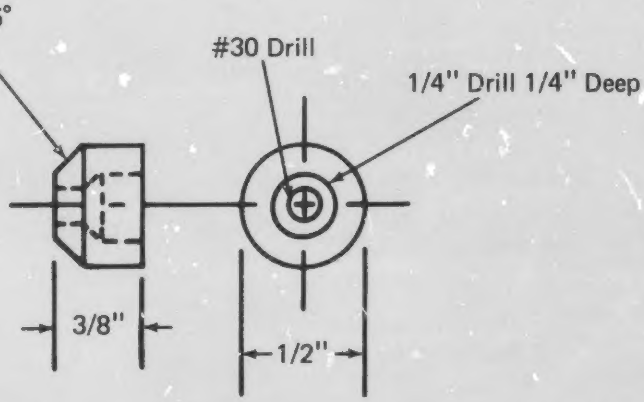
Material 2 1/4" x 2 1/4" x 5 1/2" SAE 1095

JOB SHEET #10

Blueprint of a V-Block (Parts 2 and 3)

Part 2

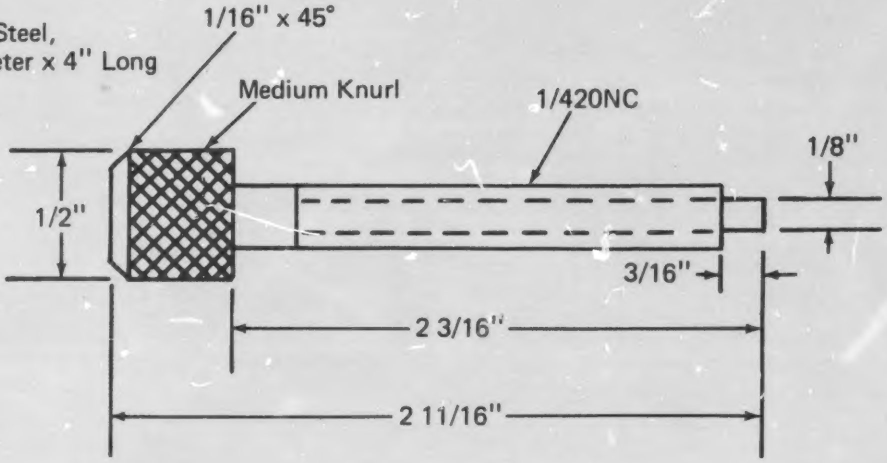
Material 1018 Steel
1/2" Diameter


1/8" x 45°
#30 Drill
1/4" Drill 1/4" Deep
3/8"
1/2"

(Note: This is from the same material as Part 3.)

Part 3

Material
SAE 1018 Steel,
1/2" Diameter x 4" Long

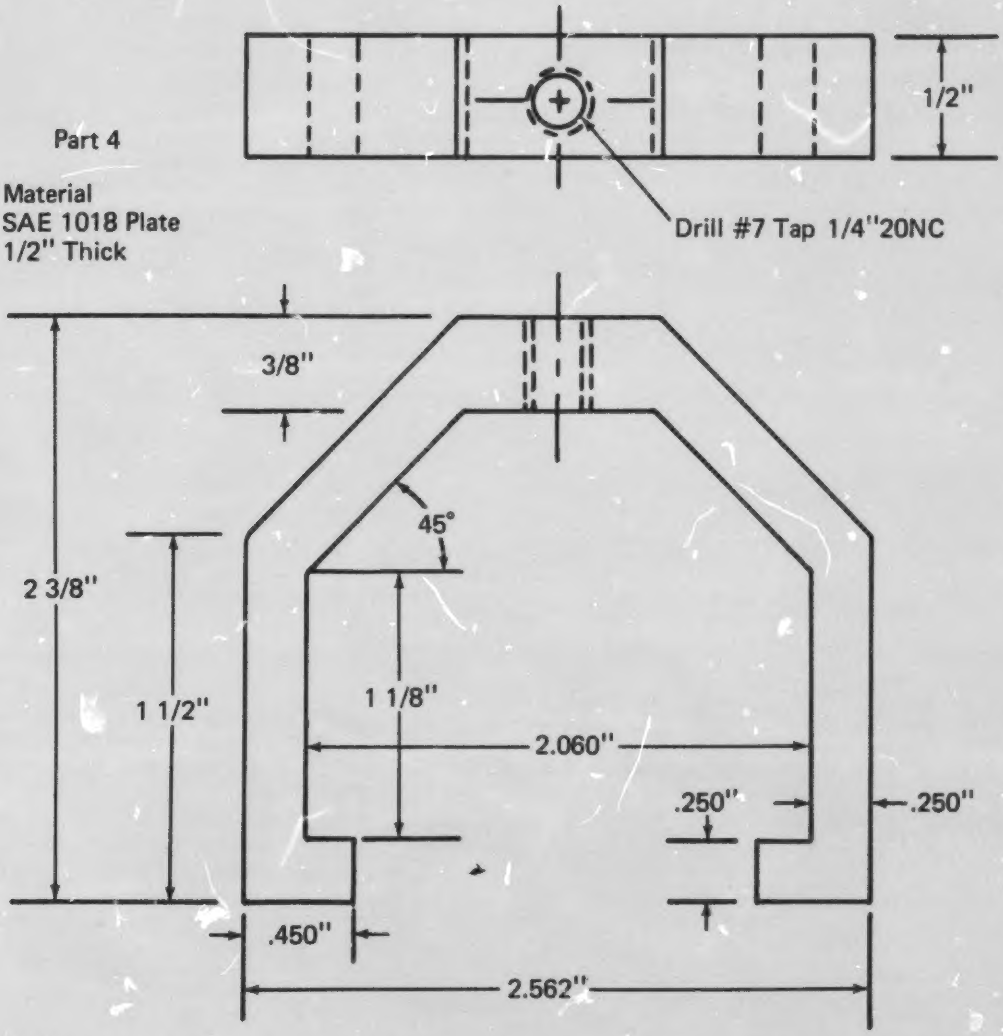

1/16" x 45°
Medium Knurl
1/420NC
1/8"
1/2"
3/16"
2 3/16"
2 11/16"

JOB SHEET #10

Blueprint of a V-Block (Part 4)

Part 4

Material
SAE 1018 Plate
1/2" Thick



1/2"
Drill #7 Tap 1/4"20NC
3/8"
45°
2 3/8"
1 1/2"
1 1/8"
2.060"
.250"
.250"
.450"
2.562"

SHAPERS
UNIT I

TEST

NAME ________________________________ SCORE ______________

1. Match terms associated with shapers to their correct definitions. Write the correct numbers in the blanks.

   ______a. Metal box attached to frame; has T-slots on which work or work-holding devices are mounted; moves in horizontal or vertical direction with power or manual feed

   ______b. Holds tool post that supports cutting tool

   ______c. Main moving part of shaper; holds and drives cutting tool

   ______d. Distance in inches that ram moves

   ______e. Back and forth movement

   ______f. Holds clapper with tool post and allows tool to move away from cut on return stroke

   ______g. Part attached to front of shaper ram; holds clapper and cutting tool, swivels right and left, and feeds slide vertically

   1. Reciprocation
   2. Ram
   3. Toolhead
   4. Table
   5. Stroke
   6. Clapper
   7. Clapper box

2. Name types of shapers.

   a. ____

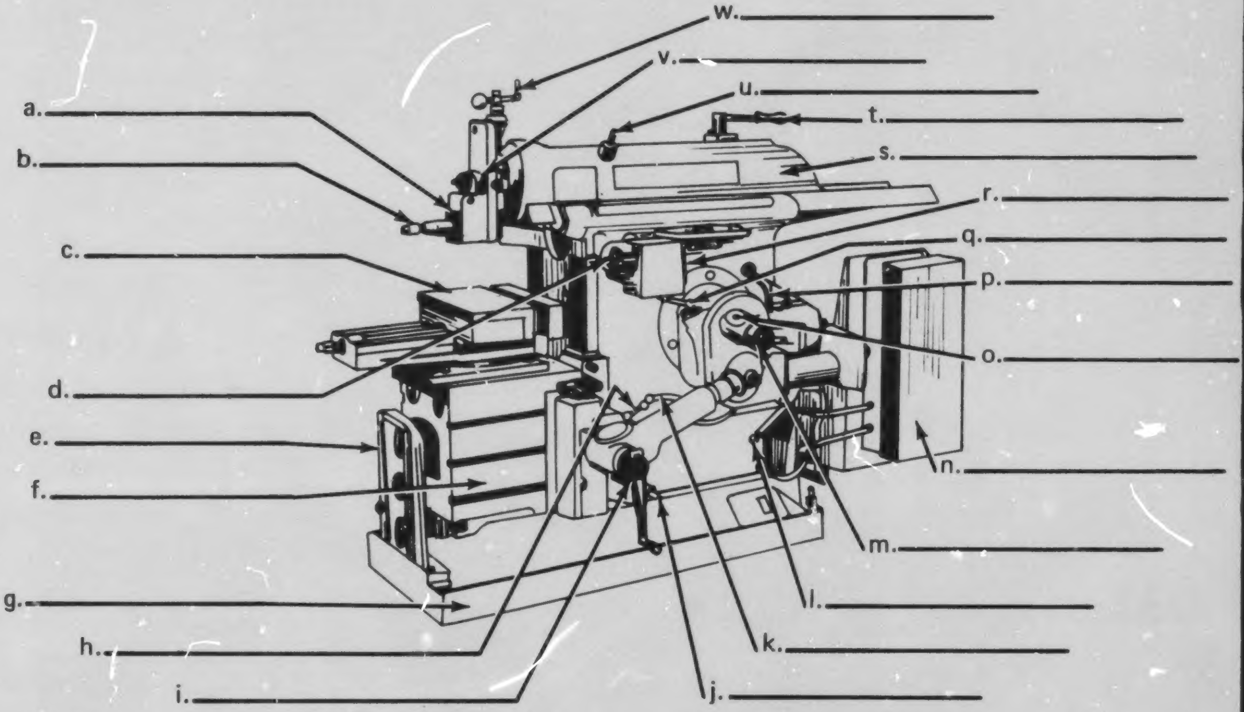
   b. ____

   c. ____

TEST

3. Identify parts of the standard crank shaper. Write the correct names in the blanks provided.

- **Down-feed handle**
- **Tool post**
- **Ram**
- **Table**
- **Back gear lever**
- **Power switch**
- **Toolhead**
- **Clapper box**
- **Cross-feed lever**
- **Clutch and brake lever**
- **Ram positioning shaft**
- **Length-of-stroke indicator**
- **Vertical-traverse shaft**
- **Stroke-adjustment shaft**
- **Vise**
- **Base**
- **Table support**
- **Cross-feed shaft and safety crank**
- **Rapid-traverse lever**
- **Electrical control box**
- **Ram positioning lock**
- **Feed-control lever**
- **Gearshaft lever**



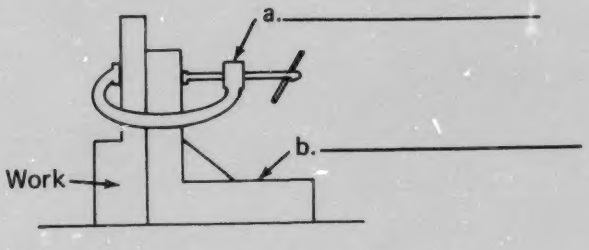
TEST

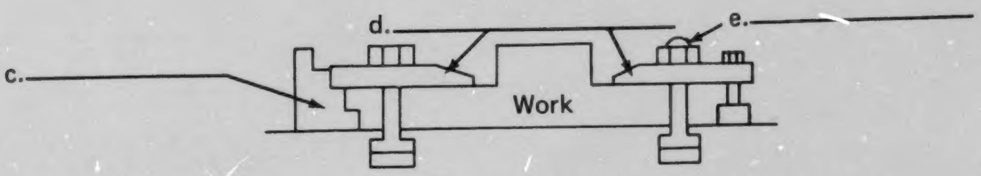
4. Identify work-holding devices in the following illustrations. Write the correct names in the blanks provided.

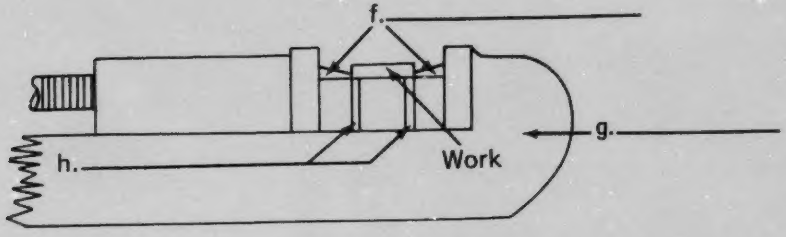
Vise
Fixture
Angle plate
T-bolt

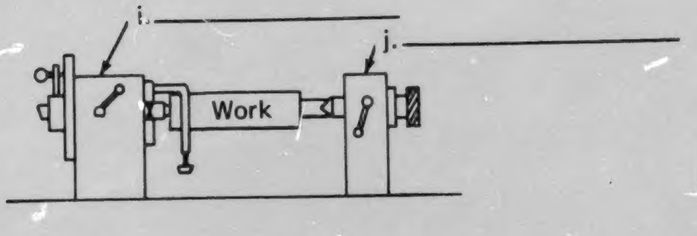
Hold-down wedges
Dividing head
V-block
Step block

C-clamp
Strap clamps
Parallels
Foot stock









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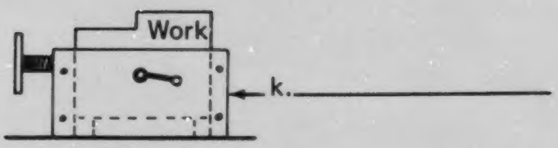
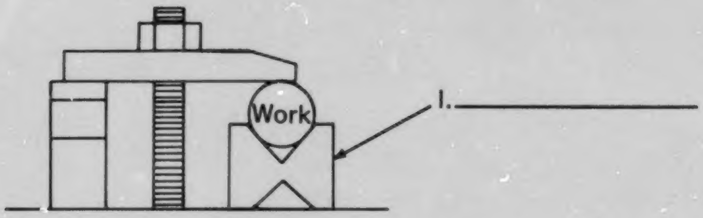




5. State rules for care and cleaning of the shaper.

   a. Cleaning-- ____________________

   ____

   b. Lubrication-- ____________________

   ____

   c. Locks-- ____________________

   ____

   d. Gear boxes-- ____________________

   ____

   e. Stroke adjustments-- ____________________

   ____

   f. Cranks-- ____________________

   ____

6. State ten rules for safe use of the shaper.

   a. ____________________

   ____

TEST

b.

c.

d.

e.

f.

g.

h.

i.

j.

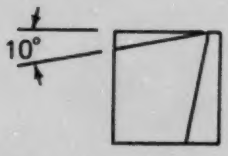
7. Name types of shaper cutting tool materials.

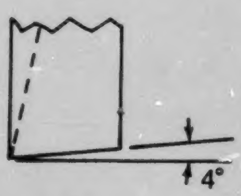
a.

b.

8. Identify angles of shaper cutting tools. Write the correct names in the blanks.

End relief	**Side rake**
Back rake	**Side relief**

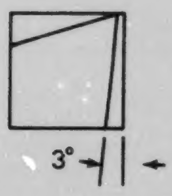


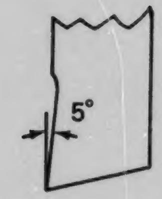


a.

b.

TEST





c. ______________________ d. ______________________

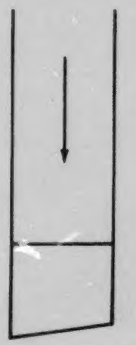
9. Identify shapes of cutting tools. Write the correct names in the blanks.

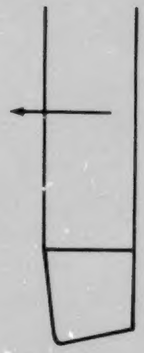
(NOTE: Arrows indicate relative movement of tool to make next cut.)

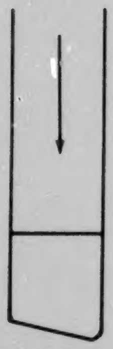
Right-hand roughing
Left-hand roughing
Round-nose contouring
Right-hand finishing

Left-hand side finishing
Left-hand finishing
Slotting
Right-hand side finishing

V-shape grooving
Neutral square-nose finishing
Left-hand side roughing



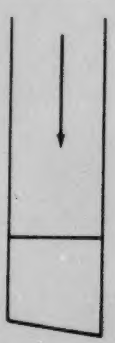


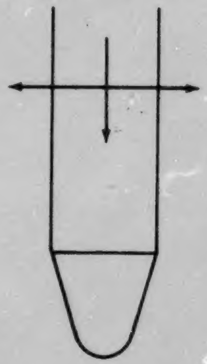


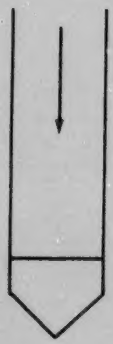
a. ______________________
____

b. ______________________
____

c. ______________________
____





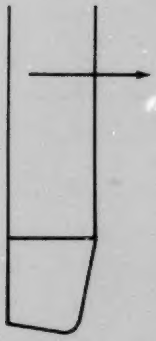


d. ______________________
____

e. ______________________
____

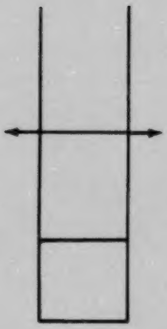
f. ______________________
____

TEST



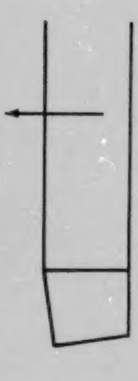
g. ____________________

____



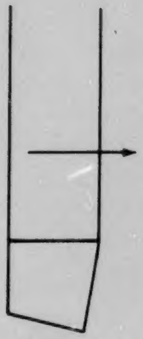
h. ____________________

____

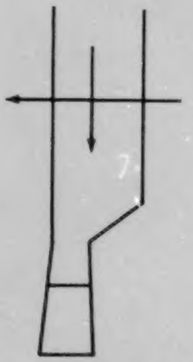


i. ____________________

____

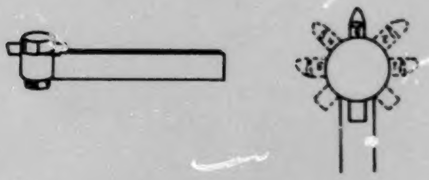


j. ____________________

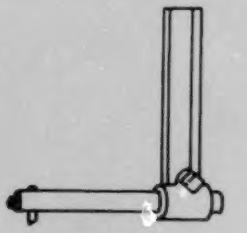


k. ____________________

10. Label types of shaper toolholders. Write the correct names in the blanks.

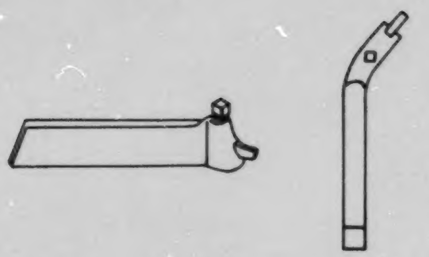


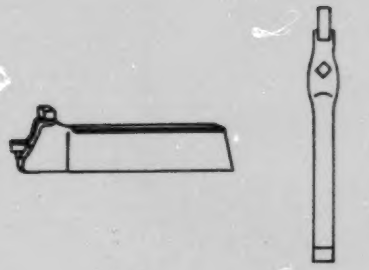
a. ____________________



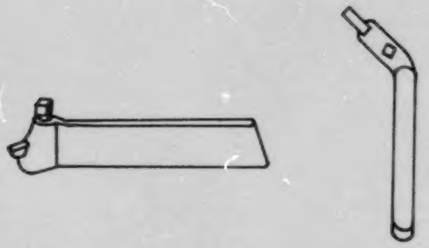
b. ____________________

TEST



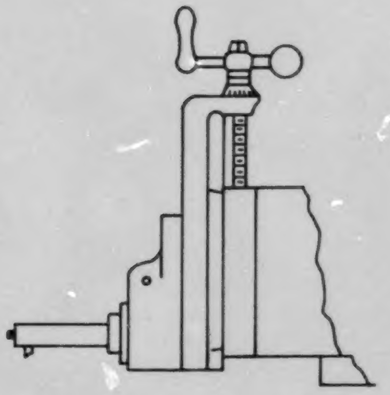


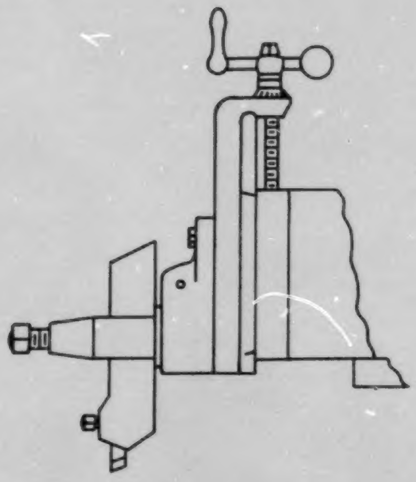
c. ____________________ d. ____________________



e. ____________________

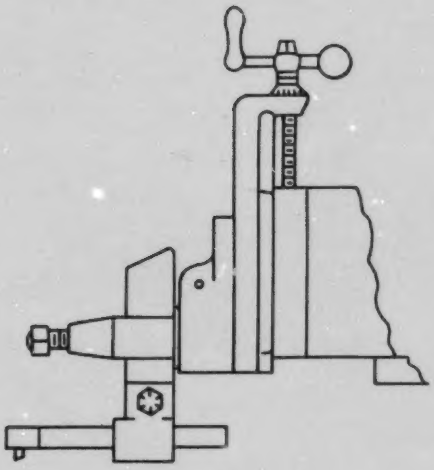
11. Name methods of holding cutting tools. Write the correct methods in the blanks.

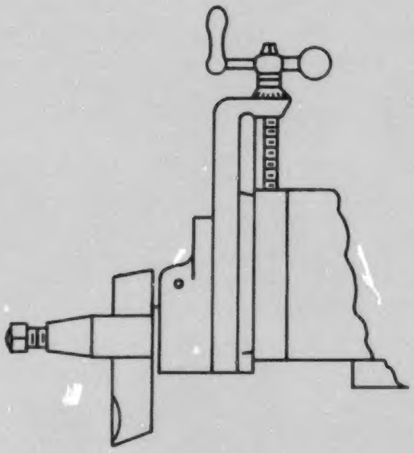




a. ____________________ b. ____________________

TEST





c. ______________________ d. ______________________

12. Name factors that affect feed and speed settings.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

TEST

13. Calculate number of strokes per minute for the following problems. Use the chart below, and show your work in the spaces provided.

Material	Cutting Speed		Feed Rough Cut		Feed Finish Cut	
	HSS	Carbide	HSS	Carbide	HSS	Carbide
Cast Iron	60	100	0.010-0.020	0.020-0.030	0.003-0.010	0.005-0.012
Mach. Steel	80	150	0.010-0.020	0.012-0.025	0.003-0.010	0.003-0.010
Tool Steel	50	150	0.010-0.030	0.010-0.030	0.005-0.015	0.003-0.012
Copper	80	200	0.020-0.060	0.010-0.020	0.003-0.012	0.005-0.015
Brass	160	300	0.010-0.030	0.005-0.060	0.003-0.010	0.005-0.015
Aluminum	200	400	0.015-0.040	0.010-0.030	0.005-0.015	0.005-0.015

a. Find the number of strokes per minute for the shaper if you are to rough surface a cast-iron plate 10" long with a high-speed steel tool.

Number of strokes = ______________________________

b. Find the number of strokes per minute when using a cemented carbide tool to shape a 1/2" slot 7" long and 1/4" deep in a plate of tool steel.

Number of strokes = ______________________________

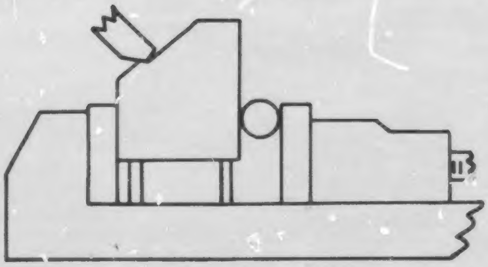
c. Find the number of strokes when using high-speed steel tool to rough and finish cut a flat surface on a plate of aluminum 11" long.

Number of strokes = ______________________________

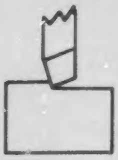
TEST

14. Identify shaper operations illustrated on this and the following pages. Write the number of the correct name in the blank provided.

    1. Machining flat surface with vertical cuts
    2. Machining flat surface with horizontal cuts
    3. Machining part square or rectangular in vise
    4. Machining angular surface
    5. Machining contour surface
    6. Machining internal dovetail
    7. Machining external dovetail
    8. Machining internal keyway
    9. Machining external keyway
    10. Machining a spline using dividing head
    11. Machining a slot

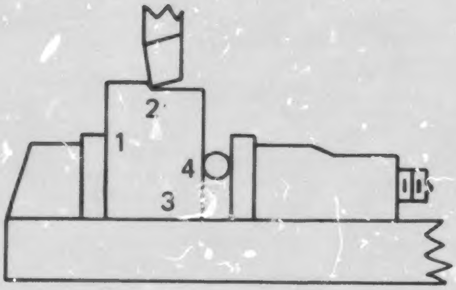


a. ____________

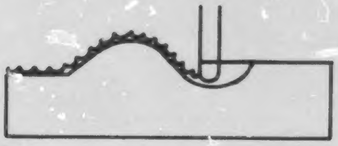


b. ____________

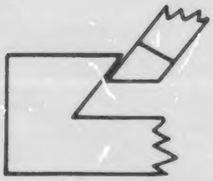
TEST



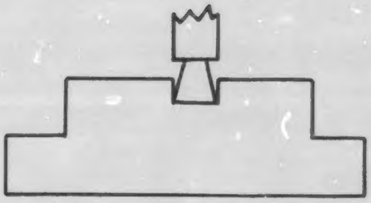
c. ____________



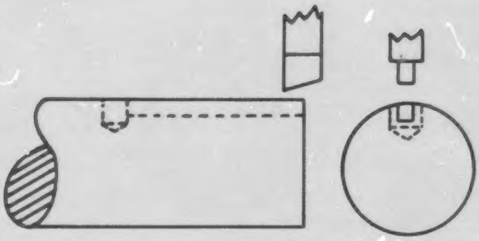
d. ____________



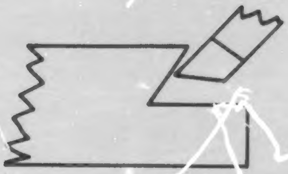
e. ____________



f. ____________

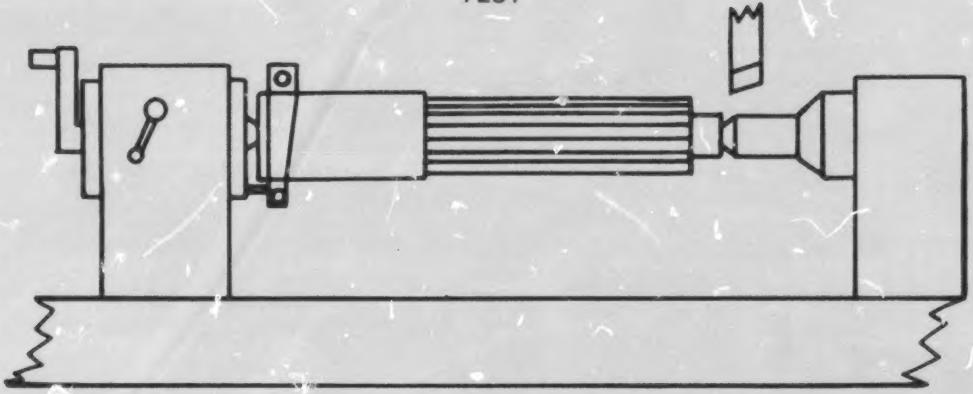


g. ____________

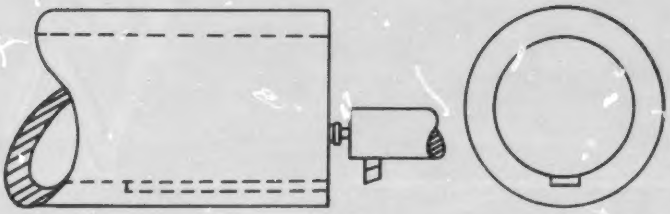


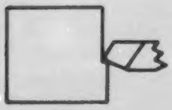
h. ____________

TEST



i. ____________





j. ____________ k. ____________

(NOTE: Test questions 15-17 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

15. Complete safety test for shaper.

16. Calculate number of strokes per minute and determine feed settings.

17. Demonstrate the ability to

    a. Grind a right-hand roughing tool.

    b. Grind a fillet cutting tool.

    c. Grind a V-shaped tool.

    d. Align vise square and flat.

    e. Set length of stroke and position ram.

    f. Set speeds and feeds.

TEST

g. Cut internal and external keyways.

h. Cut a part square and flat.

i. Cut an angular surface.

j. Cut slots and grooves.

SHAPERS
UNIT I

ANSWERS TO TEST

1. a. 4
   b. 6
   c. 2
   d. 5
   e. 1
   f. 7
   g. 3

2. a. Standard crank
   b. Hydraulic
   c. Vertical

3. a. Clapper box
   b. Tool post
   c. Vise
   d. Clutch and brake lever
   e. Table support
   f. Table
   g. Base
   h. Cross-feed lever
   i. Cross-feed shaft and safety crank
   j. Vertical-traverse shaft
   k. Rapid-traverse lever
   l. Back gear lever
   m. Stroke-adjustment shaft
   n. Electrical control box
   o. Length-of-stroke indicator
   p. Gearshaft lever
   q. Feed-control lever
   r. Power switch
   s. Ram
   t. Ram positioning lock
   u. Ram positioning shaft
   v. Toolhead
   w. Down-feed handle

4. a. C-clamp
   b. Angle plate
   c. Step block
   d. Strap clamps
   e. T-bolt
   f. Hold-down wedges
   g. Vise
   h. Parallels
   i. Dividing head
   j. Foot stock
   k. Fixture
   l. V-block

ANSWERS TO TEST

5. a. Clean with a brush when machine stops
   b. Before operating, check all sight windows for proper oil level; fill all oil cups and grease fittings
   c. Never operate feed when lock is in locked position
   d. Never change gears while machine is operating
   e. Never adjust while machine is operating
   f. Remove all hand cranks from traverse and adjusting shafts before operating machine

6. Answer should include any ten of the following
   a. Wear full face shield or approved safety glasses with side shields
   b. Be sure vise, setup, or fixture is securely fastened to table before starting machine
   c. Select proper tool and toolholder for job
   d. Make sure tool, toolhead, and table supports are secure before starting machine
   e. Never run ram into column when toolhead or toolholder is set at an angle
   f. Remove wrenches before starting machine
   g. Set speed, feeds, and depth of cut according to material being cut, cutting tool being used, and method of holding work
   h. Do not pass hands between tool and work while machine is operating
   i. Never touch tool, work, clapper, or any moving part while machine is operating
   j. Use a brush to remove chips from work and machine; use only when machine is stopped
   k. Make measurements only when machine is stopped
   l. Make adjustments only when machine is stopped
   m. Handle machined work with great care and deburr sharp edges with a file

7. a. High-speed steel
   b. Carbide-tipped

ANSWERS TO TEST

8. a. Side rake
    b. End relief
    c. Side relief
    d. Back rake

9. a. Right-hand side finishing
    b. Right-hand roughing
    c. Left-hand side roughing
    d. Left-hand side finishing
    e. Round-nose contouring
    f. V-shape grooving
    g. Left-hand roughing
    h. Neutral square-nose finishing
    i. Right-hand finishing
    j. Left-hand finishing
    k. Slotting

10. a. Multiposition
    b. Extension bar
    c. Offset right-hand
    d. Straight
    e. Offset left-hand

11. a. Mounted in tool post for internal cutting
    b. Mounted in toolholder for external cutting
    c. Mounted in toolholder for internal cutting
    d. Mounted in tool post for external cutting

12. a. Cutting tool material
    b. Kind of material being machined (cutting speed)
    c. Length of stroke (length of cut plus 1")
    d. Surface finish required

ANSWERS TO TEST

13. a. $N = \frac{60 \times 7}{11} = 38.18$ strokes per minute

    b. $N = \frac{150 \times 7}{8} = 131.25$ strokes per minute

    c. $N = \frac{200 \times 7}{12} = 116.\ 66$ strokes per minute

14. a. 4

    b. 2

    c. 3

    d. 5

    e. 6

    f. 11

    g. 9

    h. 7

    i. 10

    j. 8

    k. 1

15. Evaluated to the satisfaction of the instructor

16. Evaluated to the satisfaction of the instructor

17. Performance skills evaluated to the satisfaction of the instructor

INTRODUCTION TO LATHES
UNIT II

UNIT OBJECTIVE

After completing this unit, the student should be able to identify types of lathes and parts and accessories of the lathe. The student should also be able to state safety rules that should be observed when performing lathe work, calculate speeds and feeds, and grind basic tools used in engine lathe operations. This knowledge will be shown by completing assignment sheets, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with lathes to their correct definitions.
2. Match types of lathes to their correct uses.
3. Identify major parts of an engine lathe.
4. Identify parts of the lathe headstock.
5. Match headstock parts to their correct uses.
6. Identify parts of the lathe carriage.
7. Match carriage parts to their correct uses.
8. Identify parts of the lathe tailstock.
9. Match tailstock parts to their correct uses.
10. Match lathe accessories to their correct applications.
11. Name types of spindle drives.
12. State rules for care and cleaning of the engine lathe.
13. State rules for safe use of the engine lathe.
14. Match basic lathe operations to their correct descriptions.
15. Identify types of tool posts and toolholders.
16. List uses of types of tool posts and toolholders.
17. Define tool bit geometry.

OBJECTIVE SHEET

18. Identify basic shapes of single-point cutting tools.

19. Match types of carbide to their correct applications.

20. Compare advantages and disadvantages of carbide and high-speed steel cutting tools.

21. Use shop formulas and charts to determine lathe speeds, feeds, and depths of cut.

22. List factors to consider when calculating machining time.

23. Calculate time required to turn or bore work.

24. Complete safety test for engine lathe operations.

25. Demonstrate the ability to

    a. Free-hand grind a turning tool.

    b. Free-hand grind a facing tool.

    c. Free-hand grind a 60° threading tool.

    d. Free-hand grind a square-nose tool

    e. Sharpen a cutoff tool blade

    f. Operate lathe controls.

INTRODUCTION TO LATHES
UNIT II

SUGGESTED ACTIVITIES

I. Suggested activities

   A. Make transparencies.

   B. Provide students with objective sheet.

   C. Provide students with information, assignment, and job sheets.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   (NOTE: Assignment Sheet #3 should be completed with 100 percent accuracy.)

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Demonstrate the cutting action of carbide and high-speed tools.

   H. Discuss reasons for lathe safety and demonstrate major safety zones on lathes.

   I. Demonstrate proper gib settings.

   J. Give test.

   K. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Transparency masters

      1. TM #1--Types of Engine Lathes

      2. TM #2--Types of Engine Lathes (Continued)

      3. TM #3--Types of Engine Lathes (Continued)

      4. TM #4--Types of Engine Lathes (Continued)

      5. TM #5--Types of Engine Lathes (Continued)

      6. TM #6--Types of Engine Lathes (Continued)

      7. TM #7--Types of Engine Lathes (Continued)

SUGGESTED ACTIVITIES

8. TM #8--Major Parts of an Engine Lathe
9. TM #9--Parts of the Lathe Headstock
10. TM #10--Parts of the Lathe Carriage
11. TM #11--Parts of the Lathe Tailstock
12. TM #12--Lathe Accessories
13. TM #13--Lathe Accessories (Continued)
14. TM #14--Lathe Accessories (Continued)
15. TM #15--Lathe Accessories (Continued)
16. TM #16--Lathe Spindle Drives
17. TM #17--Bill of Materials

E. Assignment sheets

1. Assignment Sheet #1--Determine Lathe Speeds and Feeds
2. Assignment Sheet #2--Calculate Time Required to Turn or Bore Work
3. Assignment Sheet #3--Complete Safety Test for Engine Lathe Operations

F. Answers to assignment sheets

G. Job Sheets

1. Job Sheet #1--Free-hand Grind a Turning Tool
2. Job Sheet #2--Free-hand Grind a Facing Tool
3. Job Sheet #3--Free-hand Grind a 60° Threading Tool
4. Job Sheet #4--Free-hand Grind a Square-nose Tool
5. Job Sheet #5--Sharpen a Cutoff Tool Blade
6. Job Sheet #6--Operate Lathe Controls

H. Test

I. Answers to test

SUGGESTED ACTIVITIES

III. Unit references

A. Kibbe, Richard R., et al. *Machine Tool Practices*. New York: John Wiley and Sons, Inc., 1979.

B. Krar, S.F., J.W. Oswald, and J.E. St. Amand. *Technology of Machine Tools*. Toronto: McGraw-Hill of Canada, Ltd., 1969.

C. Olivo, C. Thomas. *Fundamentals of Machine Technology*. Belmont, California: Burton Publishing/Division of Wadsworth, Inc., 1981.

INTRODUCTION TO LATHES
UNIT II

INFORMATION SHEET

I. Terms and definitions

   A. Bill of materials (Transparency #17)--Complete list of all parts, hardware, and stock needed to complete a job

      (NOTE: Cost of each item may be included.)

   B. Chip breaker--Groove ground near cutting edge that causes chip to break instead of flowing as a continuous ribbon

   C. Crater resistance--Ability to resist wear caused by excessive heat generated at cutting edge by friction produced by chips moving over cutting tool

   D. Cutting edge--Edge that cuts as tool is advanced into work

   E. Cutting-edge angle--Angle of cutting edge in relation to tool shank

   F. Cutting speed--Rate at which cutting edge moves along surface of work; expressed in surface feet per minute (sfpm)

   G. Disposable inserts--Cutting tools not designed to be sharpened

   H. Engine lathe--General term for bench and floor-model lathes with headstock, bed, carriage, and tailstock

   I. Forming tool--Tool that cuts the inverse of its form on work

   J. Geared-head lathe--Lathe with headstock design that uses gear settings to produce a wide range of spindle speeds

   K. Screw-cutting lathe--Lathe with precisely controlled rate of movement between revolutions of spindle and feed of carriage

   L. Single-point cutting tool--Cutting tool with single cutting edge used to remove material from work

   M. Tool life--Period of time during which a cutting tool maintains its ability to cut efficiently between reconditionings

II. Types of lathes and their uses (Transparencies #1-#7)

   A. Bench lathe--Used to produce small parts; usually a precision machine mounted on a bench or table

   B. Floor-mounted lathe--Used for light production; most common of all engine lathes; several sizes available for various sizes of work

INFORMATION SHEET

C. Hollow-spindle lathe--Designed primarily for oil field industry; large hole through spindle holds long lengths of large-diameter work

D. Numerical-control lathe--Production machine controlled by tape or computer; performs many jobs previously done on turret and bar machines

E. Production lathe (turret lathe)--Used to produce large numbers of parts; may be operated manually or semiautomatically

EXAMPLES: Screw machines; bar chuckers; vertical turret lathes

F. Speed lathe--Small production lathe; also called a *second operation lathe*

G. Toolroom lathe--Small, floor-mounted lathe made for accuracy

III. Major parts of an engine lathe (Transparency #8)

A. Headstock

B. Bed

C. Tailstock

D. Carriage

IV. Major parts of the lathe headstock (Transparency #9)

A. Speed-change levers

B. Spindle nose

C. Lead screw

D. Feed rod

E. Foot brake

F. Motor cover

G. Feed-change levers

H. Drive belt cover

I. Switches

V. Uses of headstock parts

A. Speed-change levers--Regulate revolutions per minute that spindle turns

INFORMATION SHEET

B. Spindle nose--Part of spindle on which work-holding devices are mounted

(NOTE: The design of this driving and mounting device will vary with different manufacturers; however, the three major types are key-drive tapered spindle, cam lock spindle, and threaded spindle.)

C. Lead screw--Receives movement from headstock, and transmits power to carriage

(NOTE: If the lathe has a feed rod, the lead screw is used only when threading and cutting leads.)

D. Feed rod--Receives movement from headstock and transmits power to carriage for movement of longitudinal and cross feeds

(NOTE: Some lathes use the lead screw with a keyway to obtain power-feed movements.)

E. Foot brake--Disengages clutch and applies brake to stop machine

(NOTE: The foot brake is designed as a safety feature for emergency stops. It should not be applied hard or fast except in an emergency.)

F. Motor cover--Protective guard for motor, pump, and pulleys

G. Feed-change levers--Determine amount of feed per revolution of spindle

H. Drive belt cover--Protective guard for drive belts

I. Switches--Control power to main motor and coolant pump

(CAUTION: The on and off switches should never be used with the clutch lever engaged; make sure the clutch lever is disengaged before pushing stop button.)

VI. Parts of the lathe carriage (Transparency #10)

A. Compound rest

B. Protractor base

C. Cross-slide feed handle

D. Saddle

E. Apron

INFORMATION SHEET

F. Carriage handwheel

G. Feed-change knob

H. Feed-reverse knob

I. Feed clutch lever

J. Spindle clutch lever

K. Half-nut lever

L. Thread-chasing dial

M. Carriage-lock screw

N. Cross slide

O. Compound-rest feed handle

P. Graduated micrometer collars

VII. Uses of carriage parts (Transparency #10)

A. Compound rest--Carries toolholder; is moved with manual feed only

B. Protractor base--Allows compound rest movement along any angle

C. Cross-slide feed handle--Moves cross slide in or out with micrometer accuracy

D. Saddle--H-shaped casting which slides along the ways and carries cross slide and apron as it moves between headstock and tailstock

E. Apron--Contains carriage, cross-slide controls, and oil reservoir to lubricate saddle and other gears contained in the housing

F. Carriage handwheel--Moves carriage longitudinally; connected to a gear that meshes with rack mounted parallel to bed

G. Feed-change knob--Selects longitudinal feed or cross feed for power carriage movement

H. Feed-reverse knob--Selects direction of power movements of carriage or cross slide

I. Feed clutch lever--Engages and disengages carriage power feeds

INFORMATION SHEET

J. Spindle clutch lever--Engages and disengages driving mechanism of headstock to produce spindle rotation

(NOTE: This lever will not only turn the spindle on, but will also reverse direction of spindle rotation.)

K. Half-nut lever--Engages and disengages half-nut to lead screw in order to cut threads

L. Thread-chasing dial--Revolves with lead screw to indicate to operator when to engage half-nut lever; synchronizes movement of carriage to that of lead screw

M. Carriage-lock screw--Mechanical clamp used when performing heavy facing or cutoff operations; keeps carriage from moving longitudinally

N. Cross slide--Carries compound rest in or out by either power or manual feed

O. Compound-rest feed handle--Feeds compound rest back and forth in a straight line at angle to which protractor base of compound is set

P. Graduated micrometer collars--Allow compound and cross slide to have measured movement

(NOTE: Some graduations read direct [1 to 1]: For every 0.001" of feed, the diameter is reduced 0.001". Other graduations read 2 to 1: The diameter is reduced 0.002" for every 0.001" of feed.)

VIII. Parts of the lathe tailstock (Transparency #11)

A. Spindle-lock handle

B. Spindle

C. Tailstock offset screws

D. Tailstock lower casting

E. Tailstock upper casting

F. Handwheel

G. Clamp-bolt handle

H. Witness mark

IX. Uses of tailstock parts

A. Spindle-lock handle--Locks spindle in place

B. Clamp-bolt handle-Engages clamping mechanism that locks tailstock assembly to bed

INFORMATION SHEET

C. Handwheel--Moves spindle in or out of its housing

D. Tailstock upper casting--Houses spindle and other parts of tailstock

E. Tailstock lower casting--Supports upper casting and moves assembly along bed; provides accurate alignment

F. Tailstock offset screws--Align or set tailstock offset

G. Spindle--Holds centers, drills, reamers, and chucks with Morse tapers; moved with handwheel; graduated for reference

H. Witness mark--Indicates tailstock alignment

X. Applications of lathe accessories (Transparencies #12-#15)

A. Adjustable thread-cutting stop--Used as positive stop to feed cross feed into; eliminates need to remember how many revolutions away from work cross feed was turned

B. Ball-bearing center--Used in tailstock spindle; revolves with work, eliminating friction between work center and lathe center; allows use of higher spindle speeds

C. Bent-tail lathe dog--Clamps to round work and transmits power from drive plate to work

D. Clamping lathe dog--Used to transmit power from drive plate to work; holds square, rectangular, or round work

E. Collet chuck--Used for light-duty work on stock that is usually one inch or smaller; available for square, round, or hexagonal stock

F. Compound-turret toolholder--Allows four tools to be preset; tools can be rotated by loosening lock; excellent for short production runs

G. Drill chuck--Used to hold drills or reamers; may be mounted in headstock or tailstock of lathe

H. Drive plate (dog plate)--Used to transmit power from spindle to work by means of lathe dog; is mounted directly to spindle

I. Face plate--Used to mount work or fixtures by means of bolts and clamps when part cannot be held in a chuck or between centers; often used in production setup

J. Follower rest--Used to support long work that is usually held at both ends; mounted to the carriage, it prevents work from pushing away from tool

K. Four-jaw independent chuck--Used to hold round or irregularly shaped parts; each jaw moves independently

INFORMATION SHEET

L. High-speed threading attachment--Used when cutting threads; allows speeds two to three times faster than are normally possible

M. Knurling tool--Special tool used to produce a diamond or straight pattern on work; is held in toolholder and moves with carriage

N. Lathe centers--Used in headstock and tailstock when turning between centers; used in tailstock to support long work that must be machined

(NOTE: The center in the headstock is called a *live center* because it revolves with the work and may or may not be hardened. The center in the tailstock is called a *dead center* because it does not revolve with the work. The dead center requires lubrication [synthetic white lead]; it also must be hardened and occasionally has a carbide tip.)

O. Mandrel--Used to hold work from the inside of a round hole by means of a slight taper, and is then mounted between centers; outside diameter can be machined true to inside diameter

P. Micrometer carriage stop--Used to accurately control movement of carriage along length of bed

Q. Pipe center--Used to support inside diameter of large pipe when turning; is mounted in tailstock and revolves with work

R. Quick-change tool post--Used to mount toolholders; allows different tools to be used without adjustment each time

S. Sleeve adapter--Used to adapt tapered-shank tools to taper of tailstock

T. Soft jaws--Used on chucks with two-piece jaws; mounted in place of hard jaws so that jaws can be machined to conform to a particular radius; make holding pressure more uniform without cutting into work

U. Spindle adapter--Adapts lathe-spindle taper to Morse taper, which holds center when work is to be turned between centers; also holds drilling and reaming tools when work is mounted to carriage

V. Splash and chip guard--Used to keep coolant from being thrown from revolving chuck or work; helps stop chips from flying as they break off

W. Steady rest--Used to support long work; bolted to lathe bed

X. Taper attachment--Used to cut internal or external tapers and tapered threads without moving alignment of tailstock; graduated in degrees and inches per foot and mounted to carriage; moves carriage cross feed along desired taper when clamped to bed

Y. Three-jaw universal chuck--Used to hold round parts where concentricity is not critical; jaws can be changed or reversed for inside or outside holding; all jaws move in unison

INFORMATION SHEET

Z. Tool post--Used to hold tool or toolholder; must be adjusted each time a different tool or toolholder is used

AA. Tool-post grinder--Used to grind inside or outside diameters; mounted on carriage, which controls its movements

BB. Tracer attachment--Used to cut tapers and other contours from a pattern

XI. Types of spindle drives (Transparency #16)

A. Flat belt

B. Manual shift V-belt

C. Variable pulley

D. Geared-head

XII. Rules for care and cleaning of the engine lathe

A. Electrical power--Shut off before thoroughly cleaning machine

B. Compressed air--Use with extreme caution; do not force chips or dirt underneath felt wipers or between bearing surfaces; flying chips may cause injury

C. Cleaning--Use a brush to remove chips; wipe with clean cloth to remove dirt and sludge, and then wipe a thin coat of protective oil on all finished steel surfaces to prevent rust

D. Oil levels--Check daily

E. Lubrication-Check chart in owner's manual to determine how often to lubricate and the type of lubricant to use

F. Gibs--Never adjust before checking with instructor

G. Shear pins--Check with instructor before replacing

(CAUTION: Never use nails or wire as shear pins. Shear pins are designed to withstand a certain amount of torque, and improper pins can cause serious damage.)

H. Clutches--Report to instructor if machine pulls down or is slow to reach speed, as these actions will damage the clutch

XIII. Rules for safe use of the engine lathe (Assignment Sheet #3)

A. Eye protection--Wear approved safety glasses with side shields

B. Watches and rings--Remove before operating machinery

INFORMATION SHEET

C. Clothing--Wear close-fitting clothes with shirttail tucked into pants; roll up long sleeves past elbow, or button

D. Horseplay--Is strictly prohibited in shop area

E. Measuring, adjusting, cleaning, or oiling--Stop lathe

F. Hands--Never use hands to try to stop lathe spindle or chuck, to grab chips, or to remove hot work from work-holding device

G. Rags--Never use around revolving or moving parts

H. Guards--Never operate a machine with guards removed

I. Chuck wrench--Remove immediately; never leave in chuck

J. Floor--Keep clean and free of chips and oil to eliminate slipping and tripping hazards

K. Work-holding devices--Always check to make sure that they are mounted securely

L. Tools--Never leave lying on machine

M. Chucks--Always clean before mounting on spindle; never set directly on the ways (use a wooden chuck cradle)

N. Large or oddly shaped parts that are chucked--Rotate work a complete revolution by hand to make sure jaws and work clear the ways and carriage

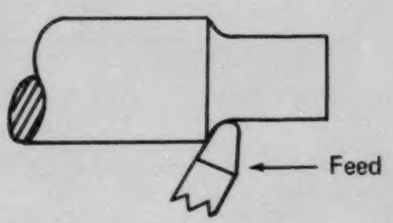
O. Sharp edges-Remove all sharp edges and burrs from work

XIV. Basic lathe operations (Figures 1-17)

A. Turning--Removing material from outside surface of part

EXAMPLE:

FIGURE 1

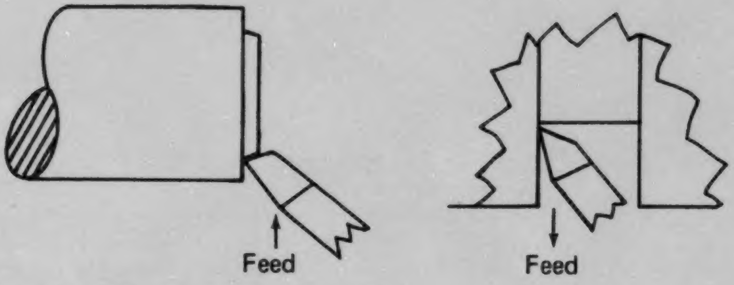


INFORMATION SHEET

B. Facing--Removing material from end surface of part

EXAMPLES:

FIGURE 2

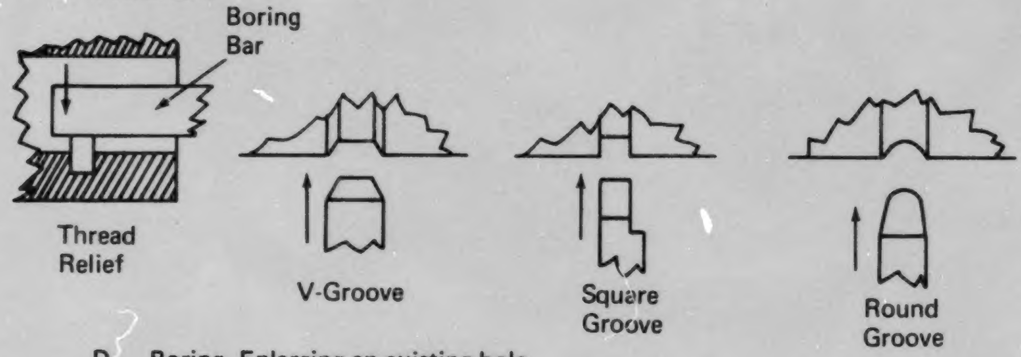


C. Grooving--Cutting a recess in work

(NOTE: Arrows indicate feed direction.)

EXAMPLES:

FIGURE 3



Thread Relief

V-Groove

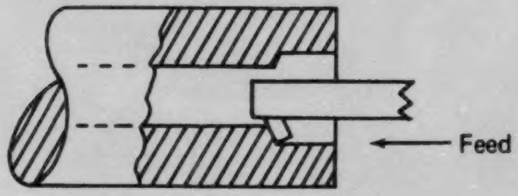
Square Groove

Round Groove

D. Boring--Enlarging an existing hole

EXAMPLE:

FIGURE 4

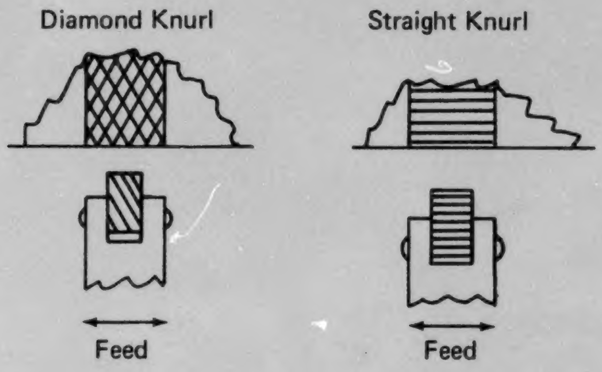


INFORMATION SHEET

E. Knurling--Producing a raised pattern on surface of work to improve grip or appearance or to increase diameter

EXAMPLES:

FIGURE 5

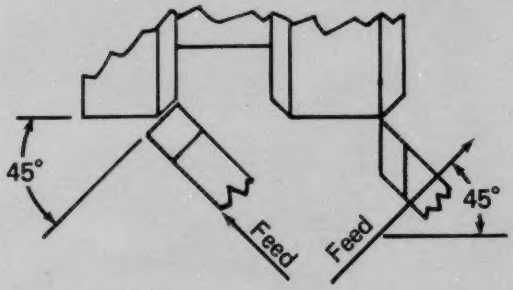

Diamond Knurl
Straight Knurl
Feed
Feed

F. Chamfering--Producing a flat, angular surface on the edge of a machined part

(NOTE: Chamfer may be cut or formed depending on its size.)

EXAMPLE:

FIGURE 6

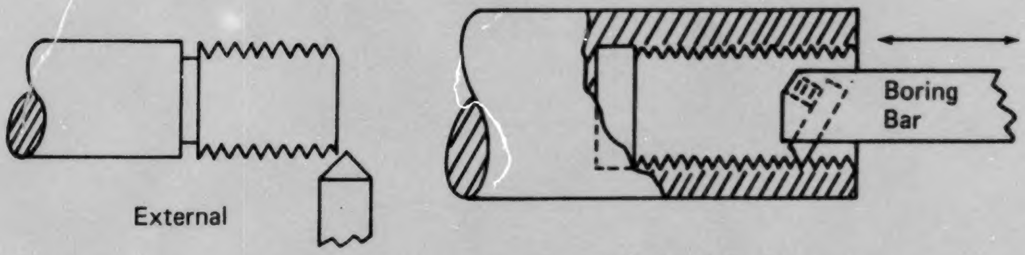

45°
Feed
Feed
45°

INFORMATION SHEET

G. Threading--Forming internal or external threads with a single-point tool

EXAMPLES:

FIGURE 7



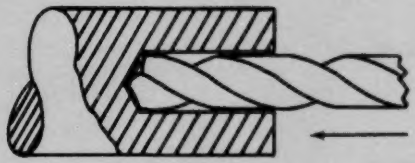
External

Internal

H. Drilling--Producing a hole with a drill

EXAMPLE:

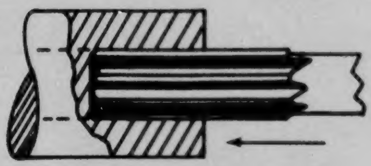
FIGURE 8



I. Reaming--Enlarging a hole slightly with a multi-fluted cutter

EXAMPLE:

FIGURE 9

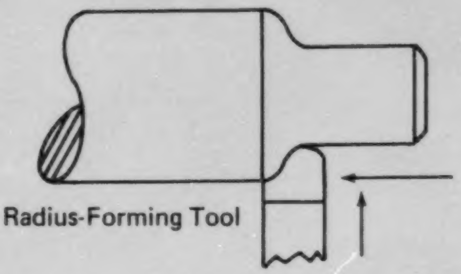


INFORMATION SHEET

J. Forming--Producing a desired shape by using a tool ground to that shape

EXAMPLE:

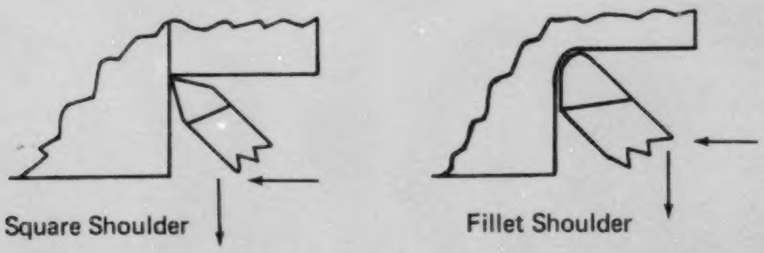
FIGURE 10


Radius-Forming Tool

K. Shouldering--Finishing surface where two diameters or steps meet

EXAMPLES:

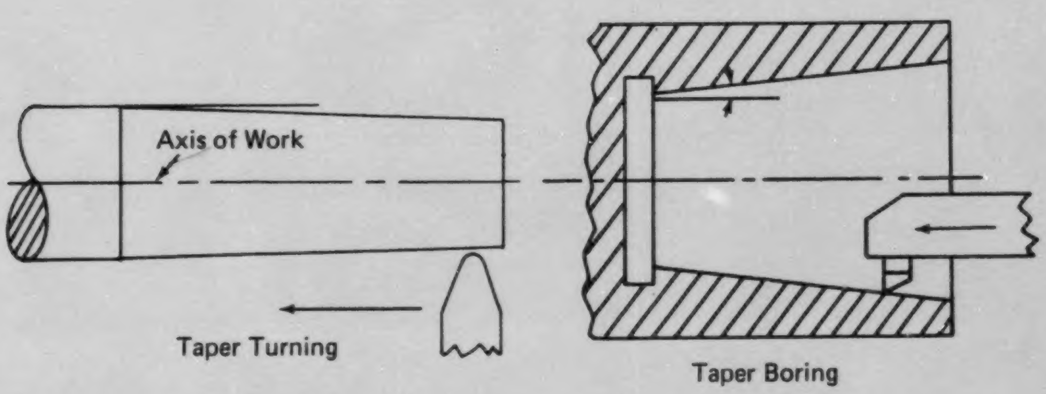
FIGURE 11


Square Shoulder
Fillet Shoulder

L. Tapering--Producing uniform change in diameter of part as measured along its axis

EXAMPLES:

FIGURE 12


Axis of Work
Taper Turning
Taper Boring

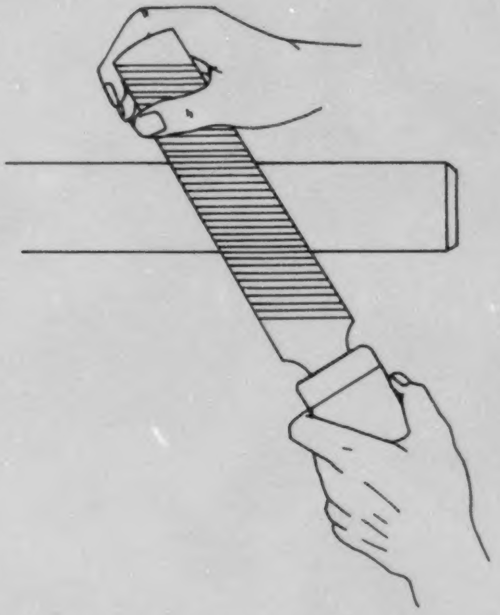
INFORMATION SHEET

M. Filing--Chamfering or reducing diameter of work with a file while work is rotating

(CAUTION: Hold file handle in your left hand when filing near chuck.)

EXAMPLE:

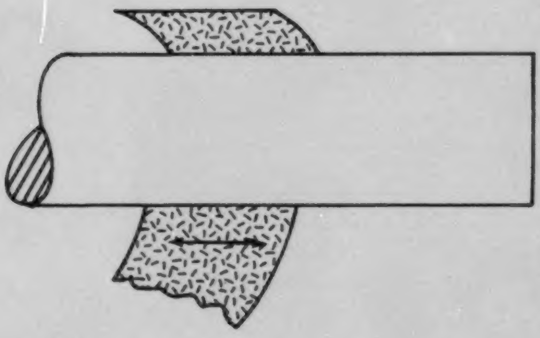
FIGURE 13



N. Polishing--Improving surface finish of part with abrasive cloth while work is turning

EXAMPLE:

FIGURE 14



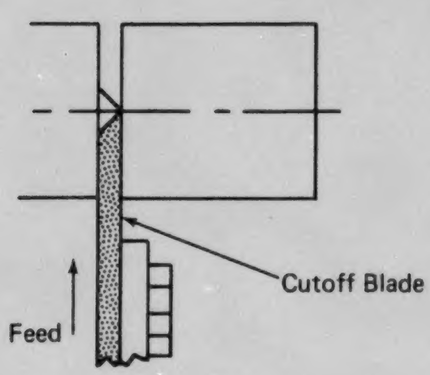
INFORMATION SHEET

O. Cutoff--Cutting a part from work with a thin tool while work is rotating

(CAUTION: Cutoff operations should never be done on work that is held between centers or supported with a center.)

EXAMPLE:

FIGURE 15

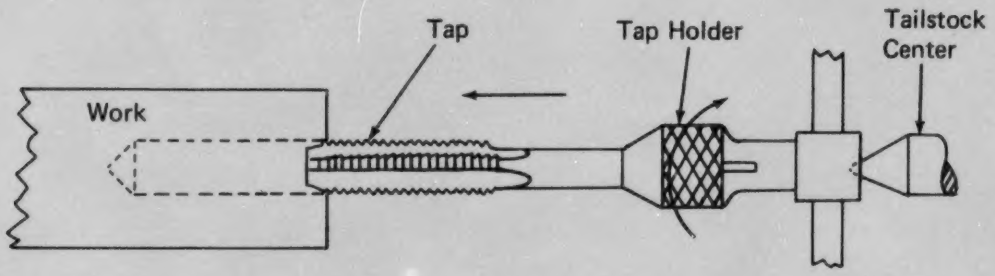

Cutoff Blade
Feed

P. Tapping--Producing internal threads with a tap, using the lathe tailstock to guide tap

(NOTE: Power is off when machinist performs this operation, and lathe is set in low range to prevent spindle from turning.)

EXAMPLE:

FIGURE 16

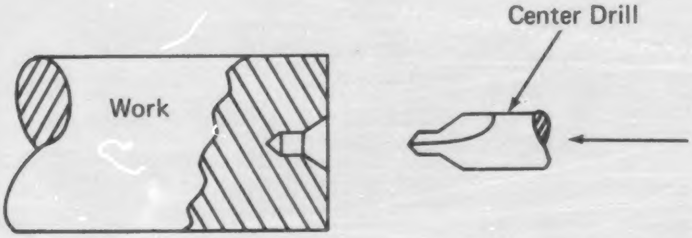

Tap
Tap Holder
Tailstock Center
Work

INFORMATION SHEET

Q. Center drilling--Producing a tapered hole in end of work so that part can be held between centers or be used as starting hole for drilling operation

EXAMPLE:

FIGURE 17

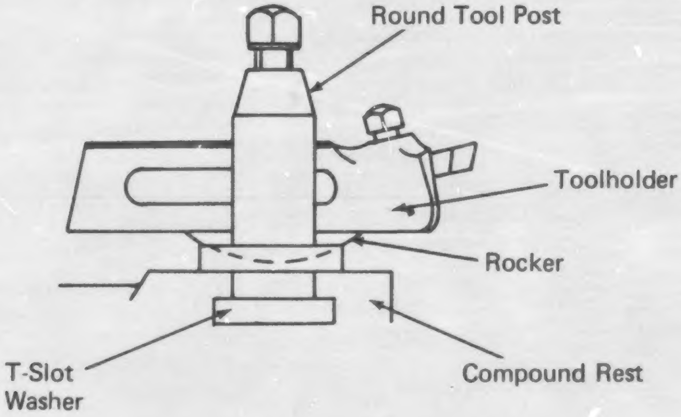

Center Drill
Work

XV. Types of tool posts and toolholders (Figures 18-23)

A. Round tool post and toolholder

(NOTE: Tool posts and holders come in a number of designs. Some designs are combination posts and holders.)

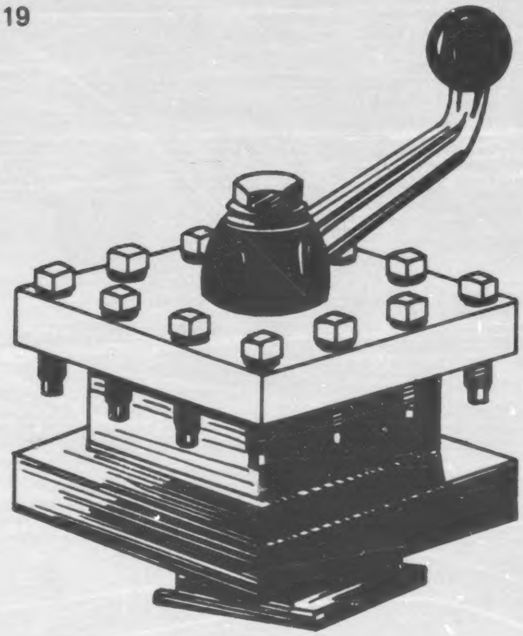
FIGURE 18


Round Tool Post
Toolholder
Rocker
T-Slot Washer
Compound Rest

INFORMATION SHEET

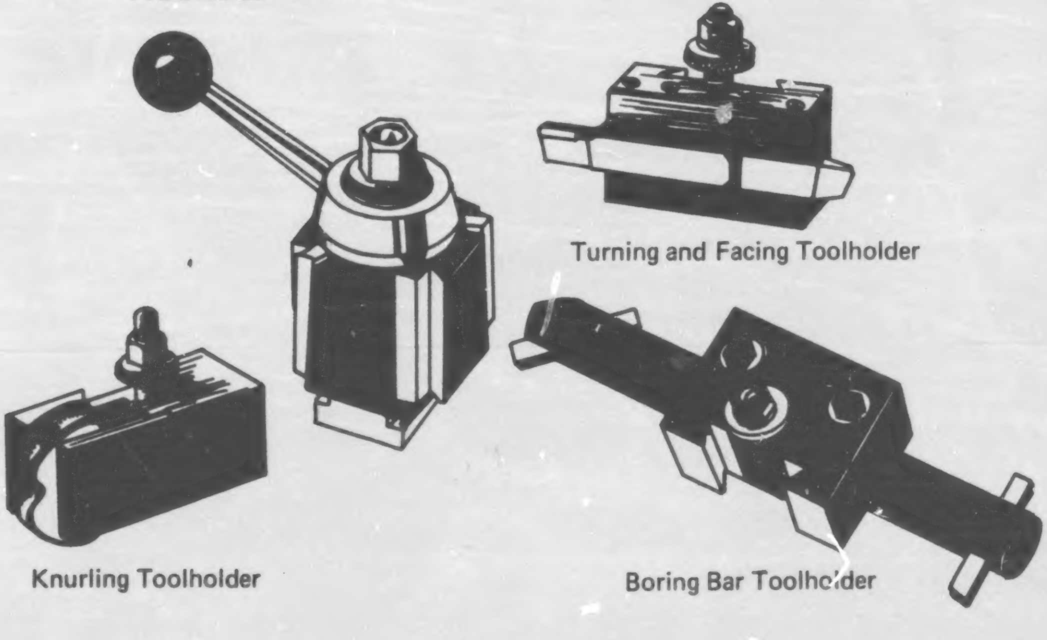
B. Compound-turret tool post (square turret)

FIGURE 19



C. Quick-change tool post and holders

FIGURE 20



Turning and Facing Toolholder

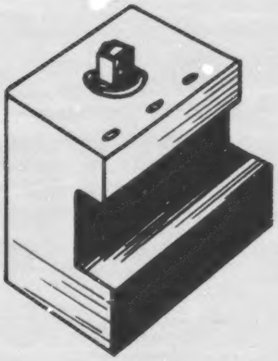
Knurling Toolholder

Boring Bar Toolholder

INFORMATION SHEET

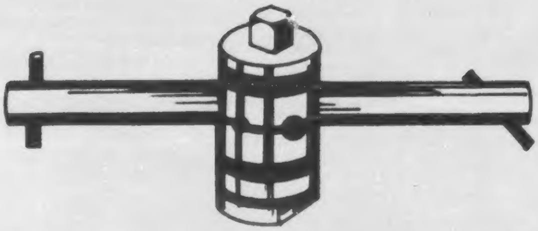
D. Heavy-duty, open-face tool post and holder

FIGURE 21



E. Boring bar and holder

Figure 22



INFORMATION SHEET

XVI. Uses of types of tool posts and toolholders

A. Round tool post and holders--Used to get into tight places when work is supported with tailstock

B. Heavy-duty, open-face post--Holds high-speed or carbide cutting tools for heavy machining

C. Quick-change toolholder--Allows tools to be preadjusted and changed without readjusting; can be used for short-run production; holds high-speed or carbide cutting tools for medium machining

D. Turret tool post and holder--Holds high-speed or carbide tools for heavy machining; holds four tools; indexes and repeats itself for production machining

E. Boring bar holder--Holds boring bar for internal turning or boring

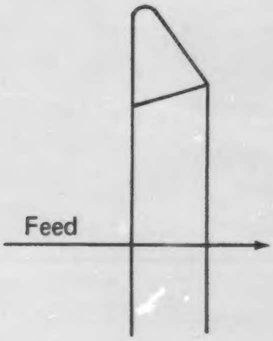
XVII. Tool bit geometry--Shape produced by grinding of proper angles on a cutting tool, allowing maximum chip removal and tool life, and producing the desired finish

XVIII. Basic shapes of single-point cutting tools

A. High-speed steel (Figures 23-32)

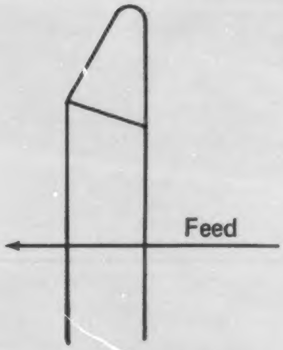
1. Left-hand turning

FIGURE 23



2. Right-hand turning

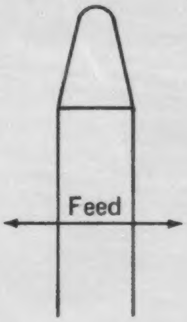
FIGURE 24



INFORMATION SHEET

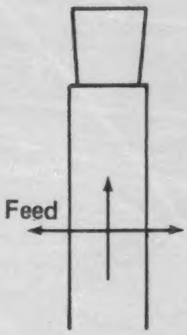
3. Round-nose turning

FIGURE 25



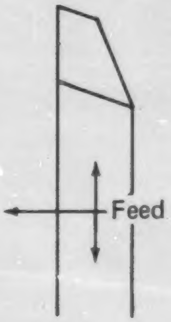
4. Square-nose chamfer or turning

FIGURE 26



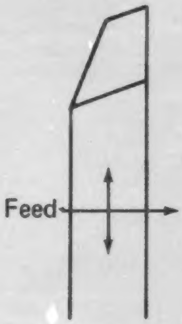
5. Right-hand facing

FIGURE 27



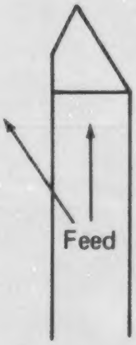
6. Left-hand facing

FIGURE 28



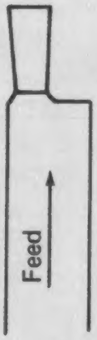
7. Threading

FIGURE 29



8. Parting or grooving

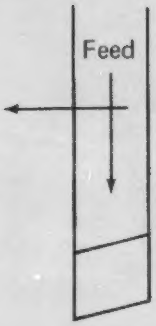
FIGURE 30



INFORMATION SHEET

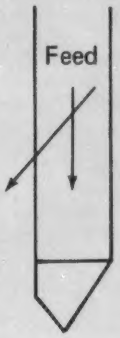
9. Boring

FIGURE 31



10. Internal threading

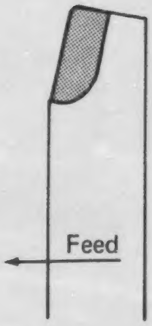
FIGURE 32



B. Brazed carbide (Figures 33-44)

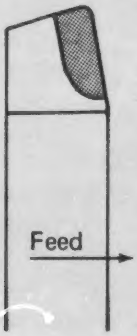
1. Right-hand rough turning

FIGURE 33



2. Left-hand rough turning

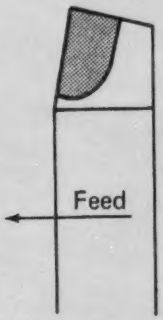
FIGURE 34



INFORMATION SHEET

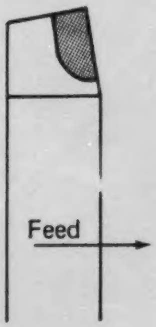
3. Right-hand finish turning

FIGURE 35



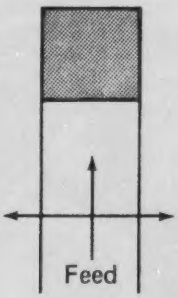
4. Left-hand finish turning

FIGURE 36



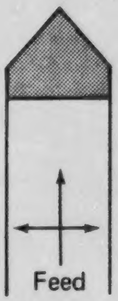
5. Square-nose chamfer or turning

FIGURE 37



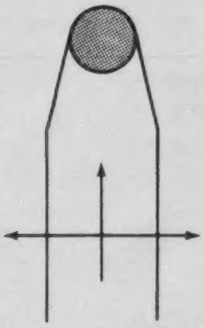
6. V-grooving or turning

FIGURE 38



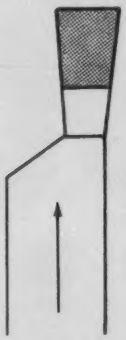
7. Round-nose grooving or turning

FIGURE 39



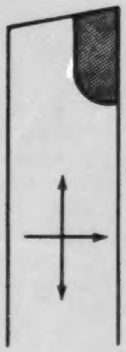
8. Parting or recessing

FIGURE 40

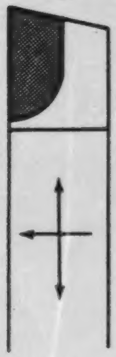


INFORMATION SHEET

9. Left-hand facing or shoulderingFIGURE 41

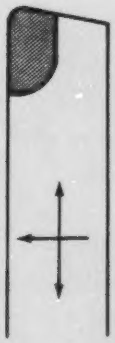


10. Right-hand facing or shoulderingFIGURE 42



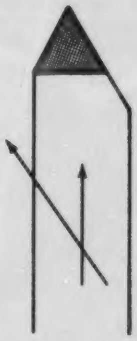
11. Right-hand rough turning or facing

FIGURE 43



12. Right-hand threading

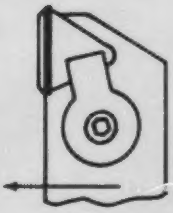
FIGURE 44



C. Carbide inserts (Figures 45-50)

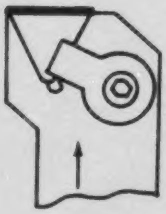
1. Right-hand turning

FIGURE 45



2. Right-hand facing

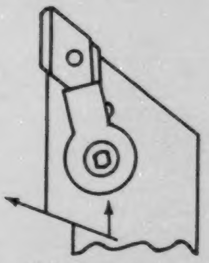
FIGURE 46



INFORMATION SHEET

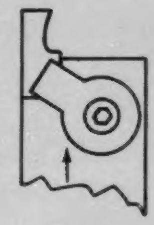
3. Right-hand tapering or contouring

FIGURE 47



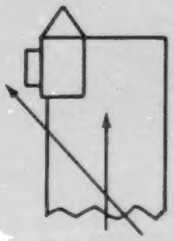
4. Right-hand grooving

FIGURE 48



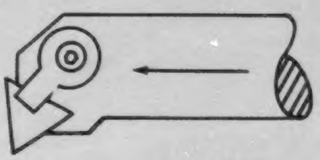
5. Right-hand threading

FIGURE 49



6. Boring

FIGURE 50



XIX. Applications of types of carbide

(NOTE: There are many grades of carbide for a variety of materials and operations. Different companies may specify a different brand and grade number.)

A. Cemented oxide (uncoated)--Used for very high-speed finishing on all types of materials; basically used for light chip loads on very rigid setups

B. Complex tungsten carbide (TiC coated)--Used for medium roughing to finishing on a broad variety of plain carbon steels, alloy steels, free-machining steels, tool steels, and 400- and 500-series stainless steels; very good general-purpose, coated grade

C. Complex tungsten carbide (uncoated)--Used for medium to very heavy roughing on a broad variety of plain carbon steels, alloy steels, tool steels, free-machining steels, 400- and 500-series stainless steels, and alloy cast irons; very good general-purpose, uncoated grade that is good for turning and milling

D. Complex tungsten carbide (Al_2O_3 coated)--Used for finishing to high-speed finishing on a broad variety of cast irons and steels

E. Straight tungsten carbide (TiC coated)--Used for light roughing to finishing on a broad variety of cast irons and steels

INFORMATION SHEET

F. Straight tungsten carbide (uncoated)--Used for medium roughing to finishing on nodular, malleable, gray, or chilled cast iron; 200- and 300-series stainless steels; a broad variety of high-temperature, high-strength alloys; and refractory alloys and nonmetals

XX. Advantages and disadvantages of carbide and high-speed steel cutting tools

A. Carbide

1. Advantages

a. Allows use of higher cutting speeds and feeds

b. Has longer tool life

c. Allows greater production output

d. Inserts are preground

e. Will machine harder materials

2. Disadvantages

a. Older machines are not rigid and lack required speeds

b. Induces internal stress in work with high carbon content

c. Easily broken or chipped

B. High-speed steel

1. Advantages

a. Can be ground easily to different shapes

b. Excellent for some nonferrous and nonmetal materials that require extreme clearance and relief angles

2. Disadvantages

a. Must be ground to shape

b. Will not withstand high temperatures

c. Must be sharpened often

d. Will not cut some very hard materials

INFORMATION SHEET

XXI. Determining speed, feed, and depths of cut, using shop formulas and charts (Assignment Sheet #1)

(NOTE: To do an effective job of lathe cutting, the work must turn at the proper speed and the tool must move at the correct feed.)

A. Determine rpm; use the formula rpm equals four times surface feet per minute (sfpm) divided by diameter of work

EXAMPLE: $\text{rpm} = \dfrac{4 \times \text{sfpm}}{D}$

(NOTE: For drilling and boring, use the diameter of the drill or the diameter of the bore. The 4 is constant.)

1. Locate on correct chart (charts at end of Information Sheet) the type of material you are going to machine

2. Use chart to determine roughing speed (over 0.150" depth of cut) and finishing speed (0.025" depth of cut) for type of cutting tool you are using

3. Put variables in formula and perform indicated math, rounding rpm to nearest whole number

EXAMPLE: Operation--Turning
Material--Low carbon steel 1020 annealed
Cutting speed (sfmp)
Roughing--High-speed steel 80
Finishing--High-speed steel 110
Diameter of work--3.0"

$$\text{Roughing rpm} = \frac{4 \times 80}{3} = \frac{320}{3} = 106.6 \text{ or } 107 \text{ rpm}$$

$$\text{Finishing rpm} = \frac{4 \times 110}{3} = \frac{440}{3} = 146.6 \text{ or } 147 \text{ rpm}$$

B. Determine feed rate

1. Locate on correct chart (charts at end of Information Sheet) the type of material to be used

2. Check feed rate for type of tool and required cut (rough or finish) for that material

C. Determine depth of cut and number of cuts

(NOTE: Diameter of work, rigidity of machine, setup, finish, and total amount to be removed are factors in determining depth of cut. For maximum depths of cut in this unit, 0.150" is used for rough turning and 0.025" for finish turning operations. Depending on amount to be removed, the depth of rough and finish cuts may need to be reduced.)

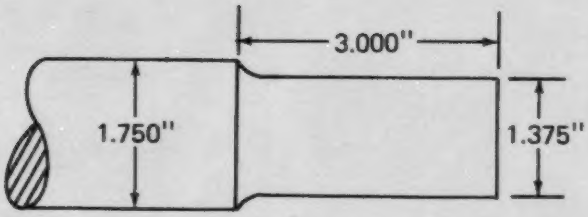
INFORMATION SHEET

1. Subtract finish diameter from starting diameter (See Example, Figure 51.)

EXAMPLE:

1.750"	Starting diameter
−1.375"	Finish diameter
0.375"	Total to be removed

FIGURE 51



2. Subtract 0.050" from total to be removed

(NOTE: Finish cut is 0.025", from each side. This results in a total of 0.050" of material to be removed in the finish cut.)

EXAMPLE:

0.375"	Total to be removed
−0.050"	Material removed by .025" finish cut
0.325"	Total amount to be removed by rough cuts

3. To determine the number of rough cuts, subtract amount of material removed with each rough cut from total amount to be removed

(NOTE: The machine, tool, and size of material are some of the factors that alter the depth of cut; make as few rough cuts as possible.)

EXAMPLE: If 0.325" is to be removed by rough cutting, make two rough cuts.

0.325"	Total amount to be removed by rough cutting
−0.300"	Material removed by 0.150" rough cut
0.025"	Amount remaining to be removed by rough cutting
−0.025"	Material removed by second rough cut
0.000	Amount remaining to be removed

4. Check diameter before making finish cut; adjust depth of cut for finish cut if necessary

(CAUTION: Care must be taken when turning work .500" or smaller as it will flex or bend under the pressure of cutting.)

INFORMATION SHEET

XXII. Factors to consider when calculating machining time (Assignment Sheet #2)

A. Speed (rpm)

B. Feed rate (ipr)

C. Length of cut

D. Number of cuts (amount of material to be removed)

(NOTE: Speed, feed, and length of cut are used when calculating time.)

$$\text{Time} = \frac{\text{Length of Cut}}{\text{Speed} \times \text{Feed}}$$

EXAMPLE: Rough turn a 2.0" piece of 1020 steel bar to a diameter of 1.750" over a length of 3.0"

$$\text{rpm} = \frac{4 \times 120}{2} = 240$$

Feed rate = 0.015 ipr

$$T = \frac{3}{240 \times 0.015} = 0.83 \text{ minutes per rough cut}$$

Finish turn a 1.750" 1020 steel bar to a diameter of 1.718" over a length of 3.0"

$$\text{rpm} = \frac{4 \times 160}{1.75} = 366$$

Feed rate = 0.007 ipr

$$T = \frac{3.00}{366 \times 0.007} = 1.17 \text{ minutes}$$

Total time required for rough and finish cuts =	0.83	Rough cut
	+ 1.17	Finish cut
	2.00	Total time

(NOTE: If more than one cut is required for either type of operation, that time must also be added. For example, if two rough cuts were necessary for the above operation, the total time would have been 2.83 minutes [0.83 + 0.83 + 1.17].)

INFORMATION SHEET

	BORING DEPTH OF CUT – INCHES 0.010		0.050		0.100		
MATERIAL	Speed sfpm	Feed ipr	Speed sfpm	Feed ipr	Speed sfpm	Feed ipr	Tool Material*
Aluminum Alloys	600	0.008	570	0.010	540	0.015	H
--Wrought	1100	0.010	1040	0.015	990	0.020	C
Brass	400	0.008	380	0.010	360	0.015	H
330-340-353	800	0.010	760	0.015	720	0.020	C
Cast Iron	140	0.006	135	0.008	125	0.010	H
Soft	460	0.008	435	0.010	415	0.015	C
Cast Iron	50	0.005	45	0.007	40	0.008	H
Hard	225	0.007	210	0.009	200	0.010	C
Carbon Steel (Lo)	125	0.005	120	0.007	110	0.010	H
1010-1020	450	0.006	425	0.010	400	0.015	C
Carbon Steel (Med)	80	0.004	75	0.005	70	0.007	H
1030-1055	320	0.005	305	0.007	290	0.009	C
Carbon Steel (Hi)	65	0.004	60	0.005	55	0.007	H
1060-1095	270	0.005	255	0.007	240	0.009	C
Alloy Steel (Med C)	80	0.005	75	0.007	70	0.008	H
4130-4140	315	0.006	295	0.009	280	0.012	C
Tool Steel (HS)	50	0.004	45	0.005	45	0.007	H
M-3, M-4, M-7	200	0.005	190	0.007	180	0.009	C
Stainless Steel	95	0.005	90	0.007	85	0.008	H
300 Series	400	0.006	380	0.009	360	0.010	C
Stainless Steel	140	0.005	130	0.007	125	0.008	H
400 Series	450	0.006	425	0.009	400	0.010	C

*H=High-speed steel

*C=Carbide

(NOTE: Although these cutting speeds can be used to calculate lathe spindle speeds, such speeds are approximate values and need to be adjusted for type and condition of machine, exact dimensions of operation, type of material being machined, and operator skill and experience.)

INFORMATION SHEET

MATERIAL	Speed sfpm (CS)	DRILLING FEED – INCHES PER REVOLUTION NOMINAL HOLE DIAMETER – INCHES 1/16	1/8	1/4	1/2	3/4	1	1 1/2	2	Tool Material*
Aluminum Alloys	140	0.001	--	--	--	--	--	--	--	H
--Wrought	275	--	0.003	0.007	0.012	0.016	0.019	0.025	.030	H
Brass	140	0.001	--	--	--	--	--	--	--	H
330-340-353	200	--	0.003	0.006	0.010	0.013	0.016	0.021	0.025	H
Cast Iron	90	0.001	--	--	--	--	--	--	--	H
(Soft)	160	--	0.003	0.006	0.010	0.015	0.018	0.021	0.025	H
	350	--	0.003	0.006	0.010	0.014	0.017	0.021	0.025	C
Cast Iron	55	0.001	--	--	--	--	--	--	--	H
(Hard)	80	--	0.002	0.004	0.007	0.010	0.012	0.015	0.017	H
	180	--	0.002	0.004	0.007	0.010	0.012	0.015	0.017	C
Carbon Steel (Lo)	65	0.001	--	--	--	--	--	--	--	H
1010-1020	90	--	0.003	0.005	0.009	0.012	0.014	0.018	0.022	H
Carbon Steel (Med)	55	0.001	--	--	--	--	--	--	--	H
1030-1055	75	--	0.003	0.005	0.009	0.012	0.014	0.018	0.022	H
Carbon Steel (Hi) 1060-1095	45	--	0.002	0.004	0.007	0.010	0.012	0.015	0.018	H
Alloy Steel (Med C) 4130-4140	65	0.001	0.003	0.006	0.010	0.014	0.016	0.020	0.023	H
Tool Steel (HS) M-3, M-4, M-7	35	0.001	0.002	0.003	0.005	0.007	0.008	0.011	0.013	H
Stainless Steel 300 Series	120	0.001	0.003	0.006	0.010	0.014	0.017	0.021	0.025	H
Stainless Steel	100	0.001	--	--	--	--	--	--	--	H
400 Series	125	--	0.003	0.006	0.010	0.014	0.017	0.021	0.025	H

*H=High-speed steel
C=Carbide

(NOTE: Although these cutting speeds can be used to calculate lathe spindle speeds, such speeds are approximate values and need to be adjusted for type and condition of machine, exact dimensions of operation, type of material being machined, and operator skill and experience.)

INFORMATION SHEET

MATERIAL	Speed sfpm (CS)	CUTOFF AND FORMING FEED — INCHES PER REVOLUTION								Tool Material*
		Cutoff Width-Inches		or		Forming Width-Inches				
		0.062	0.125	0.250	0.500	0.750	1.000	1.500	2.000	
Aluminum Alloys	500	0.003	0.003	0.004	0.004	0.0035	0.003	0.0025	0.002	H
--Wrought	825	0.002	0.006	0.008	0.005	0.004	0.004	0.003	0.0025	C
Brass	340	0.003	0.004	0.005	0.003	0.002	0.002	0.002	0.001	H
330-340-353	600	0.003	0.004	0.005	0.007	0.006	0.005	0.004	0.003	C
Cast Iron	125	0.004	0.006	0.008	0.008	0.006	0.006	0.005	0.004	H
Soft	345	0.008	0.012	0.015	0.016	0.012	0.012	0.010	0.008	C
Cast Iron	50	0.002	0.003	0.003	0.003	0.0025	0.002	0.0015	0.0015	H
Hard	165	0.004	0.006	0.007	0.005	0.005	0.004	0.0035	0.003	C
Carbon Steel (Lo)	110	0.0015	0.002	0.0025	0.0025	0.002	0.0015	0.0015	0.001	H
1010-1020	360	0.0045	0.006	0.0075	0.005	0.004	0.0035	0.0035	0.0025	C
Carbon Steel (Med)	65	0.001	0.0015	0.002	0.0015	0.0015	0.001	0.001	0.0007	H
1030-1055	230	0.003	0.0045	0.006	0.003	0.003	0.0025	0.0025	0.0015	C
Carbon Steel (Hi)	55	0.001	0.0015	0.002	0.0015	0.0015	0.001	0.001	0.0007	H
1060-1095	190	0.003	0.0045	0.006	0.003	0.003	0.0025	0.0025	0.0015	C
Alloy Steel (Med C)	65	0.0015	0.002	0.0025	0.0025	0.002	0.0015	0.0015	0.001	H
4130-4140	225	0.0045	0.006	0.007	0.005	0.004	0.0035	0.0035	0.0025	C
Tool Steel (HS)	55	0.001	0.001	0.0015	0.0015	0.001	0.001	0.0007	0.0007	H
M-3, M-4, M-7	200	0.002	0.003	0.0045	0.003	0.0025	0.002	0.0015	0.0015	C
Stainless Steel	100	0.0015	0.002	0.002	0.0025	0.002	0.002	0.0015	0.001	H
300 Series	325	0.004	0.005	0.008	0.006	0.005	0.004	0.004	0.003	C
Stainless Steel	25	0.0015	0.002	0.0025	0.0025	0.002	0.002	0.0015	0.001	H
400 Series	40	0.004	0.005	0.007	0.005	0.004	0.004	0.0035	0.0035	C

*H=High-speed steel
C=Carbide

(NOTE: Although these cutting speeds can be used to calculate lathe spindle speeds, such speeds are approximate values and need to be adjusted for type and condition of machine, exact dimensions of operation, type of material being machined, and operator skill and experience.)

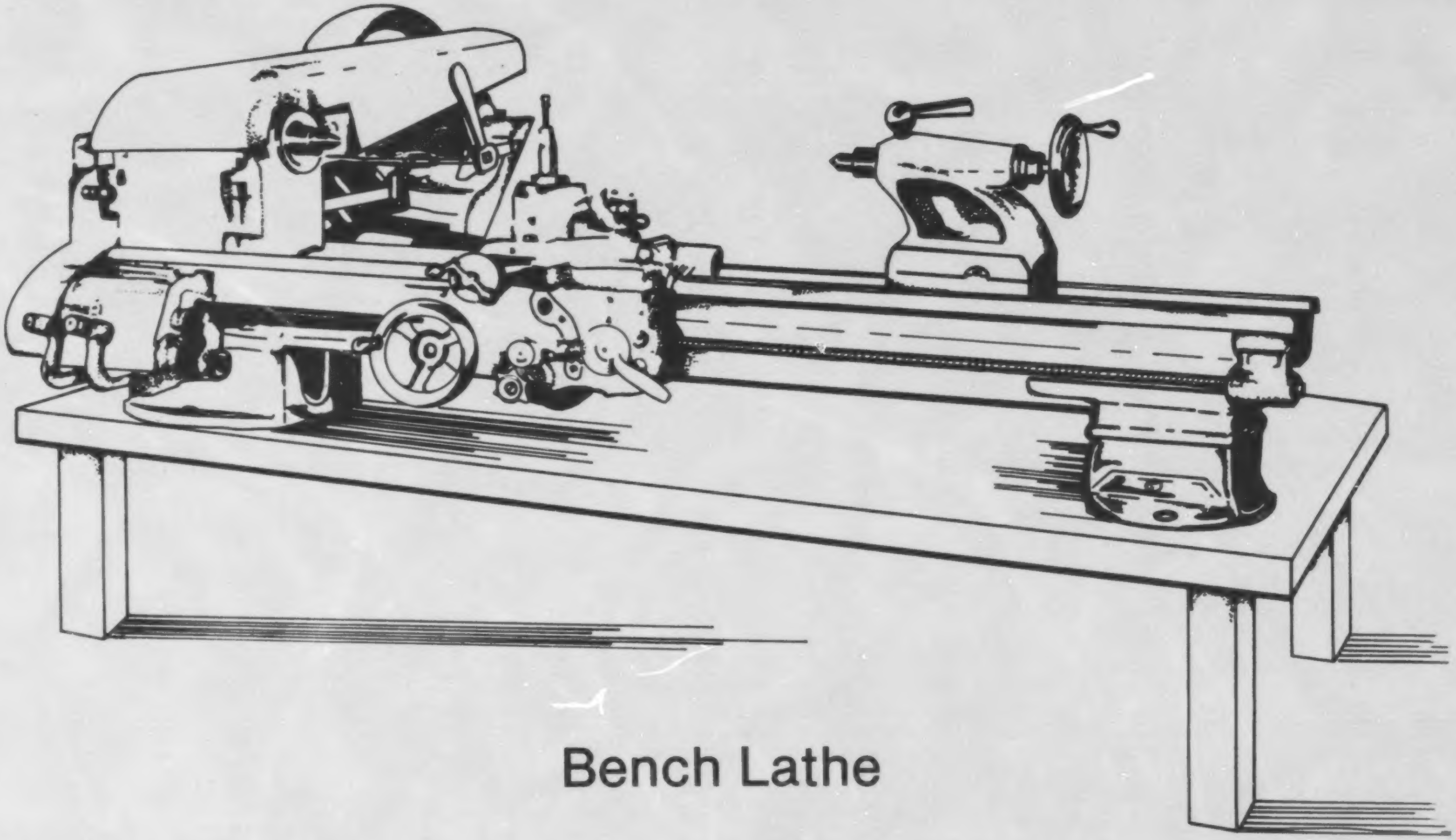
INFORMATION SHEET

TURNING							
			HIGH-SPEED STEEL TOOL		CARBIDE TOOL		
MATERIAL	Finish*	Depth of Cut (Inches)	Speed sfpm (CS)	Feed ipr	Speed SFPM (CS) Brazed	Throw-away	Feed ipr
Aluminium Alloys	R	0.150	600	0.015	1100	1500	0.020
--Wrought	F	0.025	800	0.007	1400	1800	0.010
Brass	R	0.150	400	0.015	800	925	0.020
330-340-353	F	0.025	480	0.007	960	1100	0.007
Cast Iron	R	0.150	145	0.015	500	550	0.020
Soft	F	0.025	185	0.007	650	725	0.010
Cast Iron	R	0.150	80	0.015	300	340	0.015
Hard	F	0.025	120	0.007	360	410	0.007
Carbon Steel (Lo)	R	0.150	120	0.015	400	485	0.020
1010-1020	F	0.025	160	0.007	475	625	0.007
Carbon Steel (Med)	R	0.150	75	0.015	300	375	0.020
1030-1055	F	0.025	105	0.007	385	475	0.007
Carbon Steel (Hi)	R	0.150	65	0.015	275	345	0.015
1060-1095	F	0.025	85	0.007	360	440	0.007
Alloy Steel (Med C)	R	0.150	90	0.015	300	400	0.020
4130-4140	F	0.025	120	0.007	400	500	0.007
Tool Steel (HS)	R	0.150	60	0.015	250	290	0.015
M-3, M-4, M-7	F	0.025	65	0.007	275	320	0.007
Stainless Steel	R	0.150	105	0.015	425	475	0.015
300 Series	F	0.025	125	0.007	475	520	0.007
Stainless Steel	R	0.150	150	0.015	475	525	0.015
400 Series	F	0.025	170	0.007	525	590	0.007

*"R" designates rough cut depths to cut; "F" designates finish cut depths of cut.

(NOTE: Although these cutting speeds can be used to calculate lathe spindle speeds, such speeds are approximate values and need to be adjusted for type and condition of machine, exact dimensions of operation, type of material being machined, and operator skill and experience.)

Types of Engine Lathes



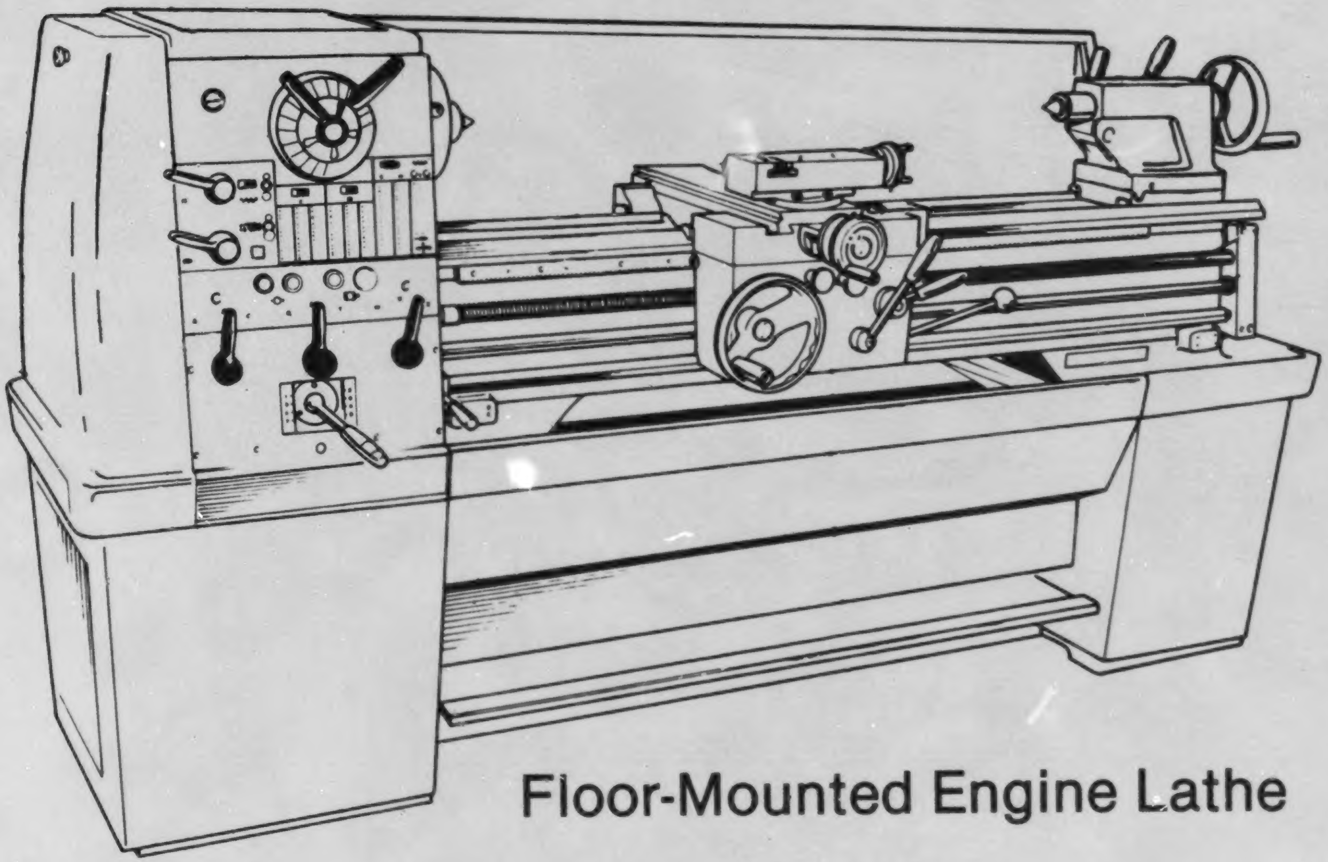
Bench Lathe

TM #1

MS II - 147

Types of Engine Lathes

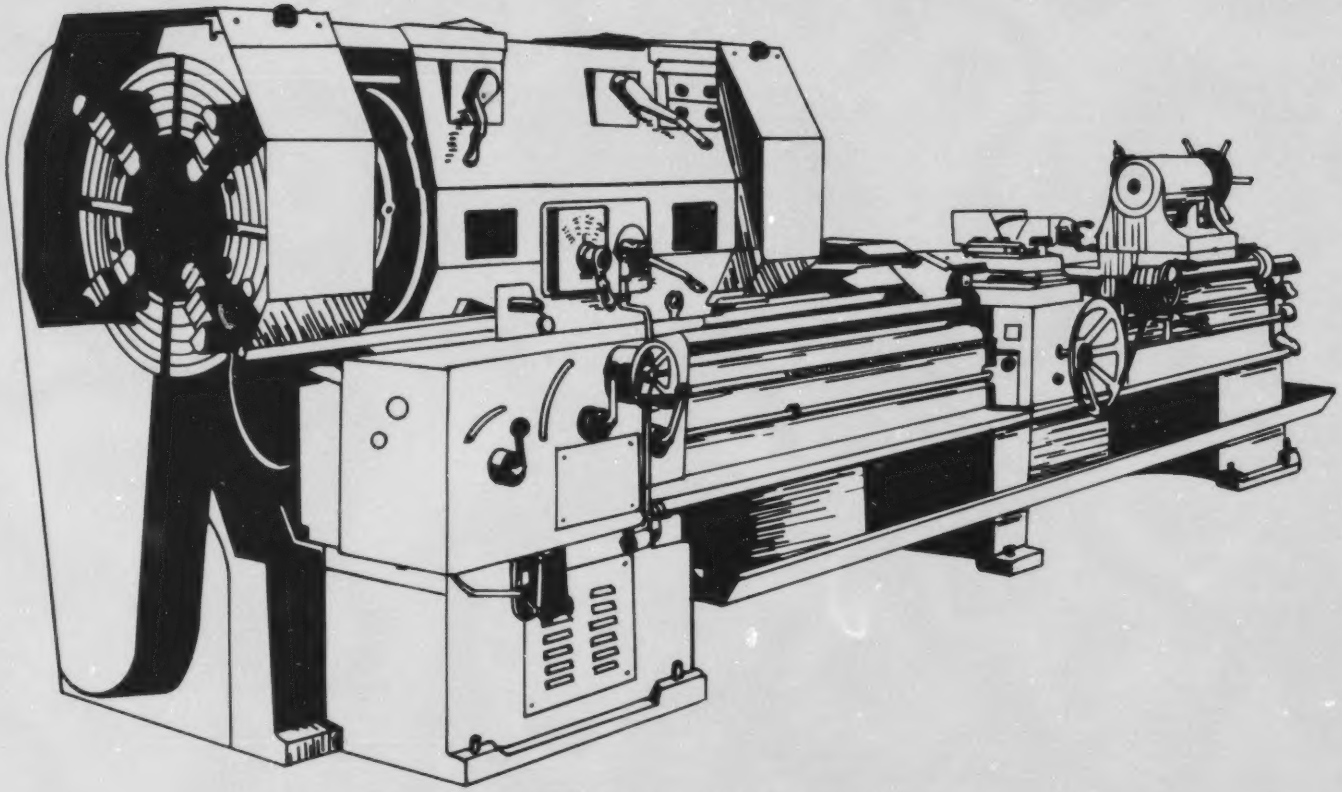
(Continued)



Floor-Mounted Engine Lathe

Types of Engine Lathes

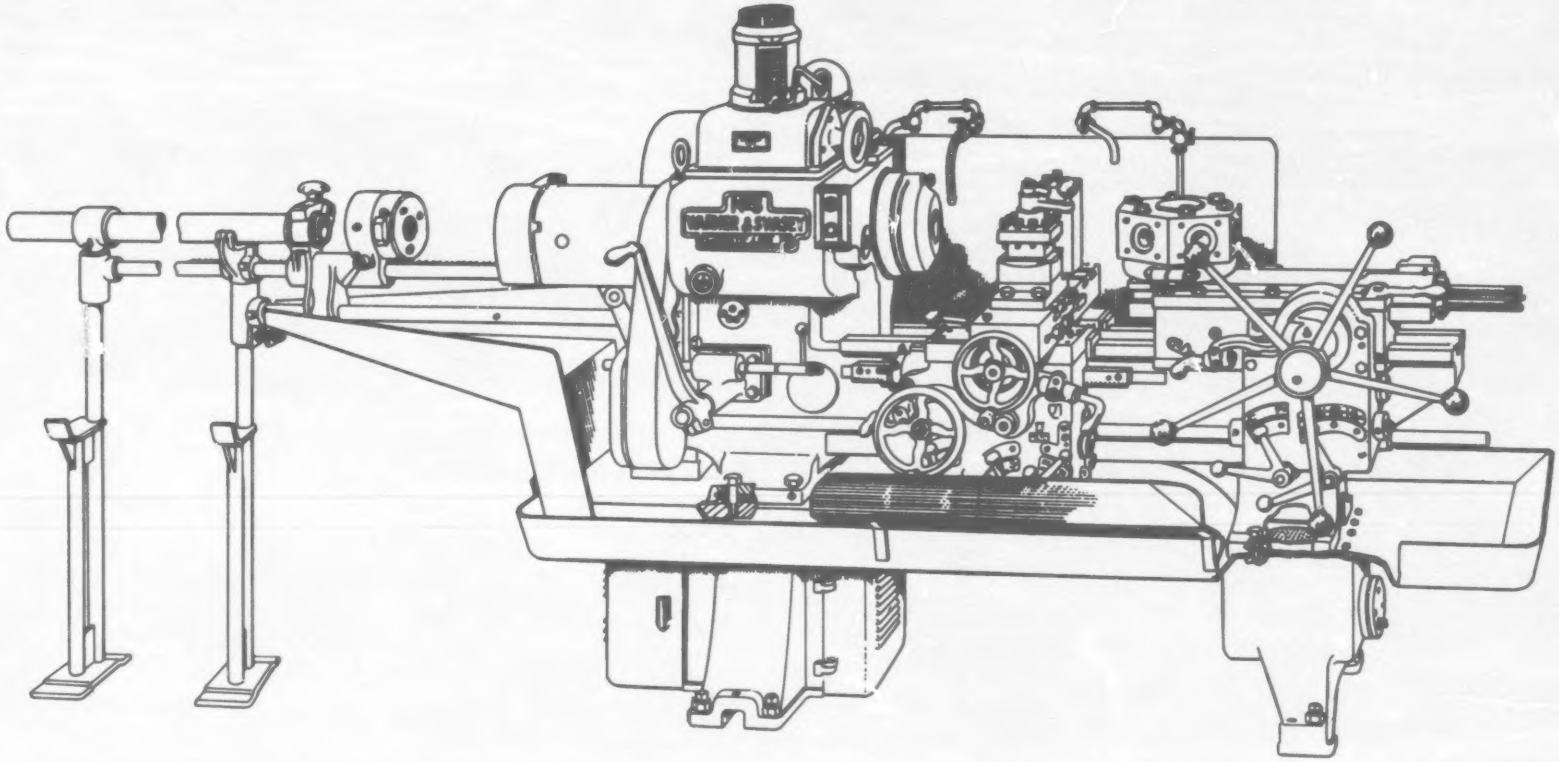
(Continued)



Hollow Spindle Lathe

Types of Engine Lathes

(Continued)

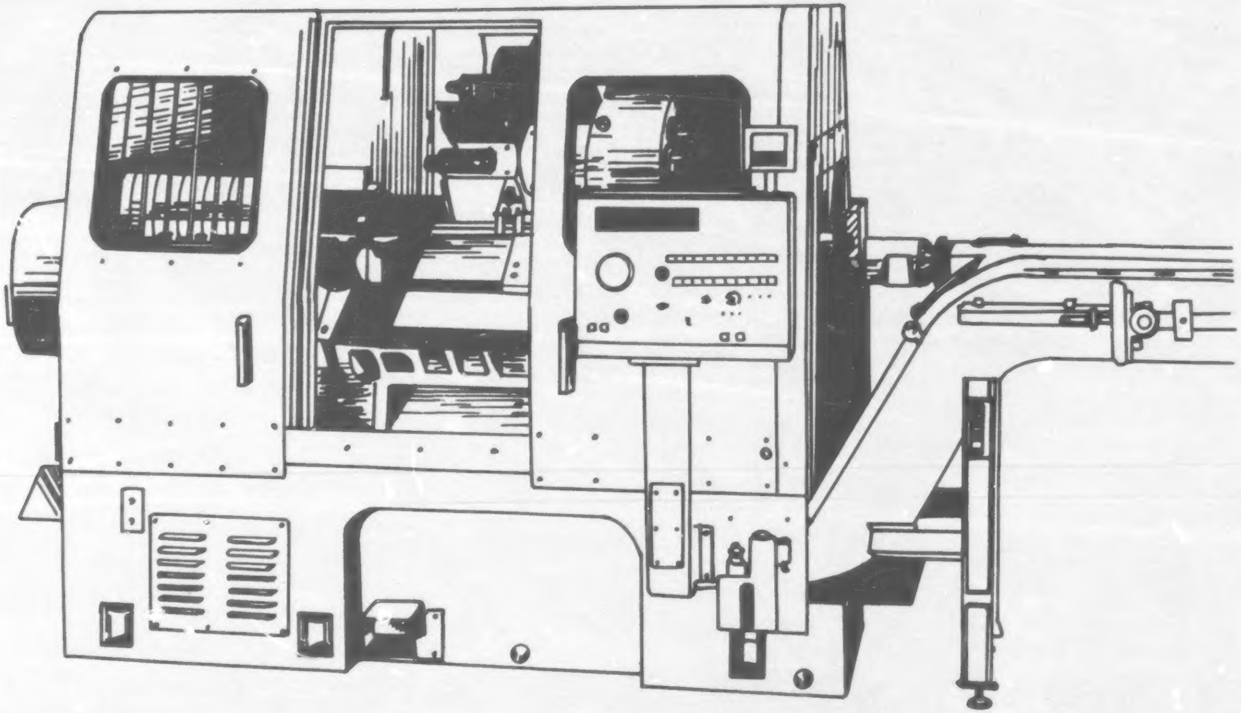


Production Lathe (Turret Lathe)

Adapted with permission of the Warner & Swasey Company.

Types of Engine Lathes

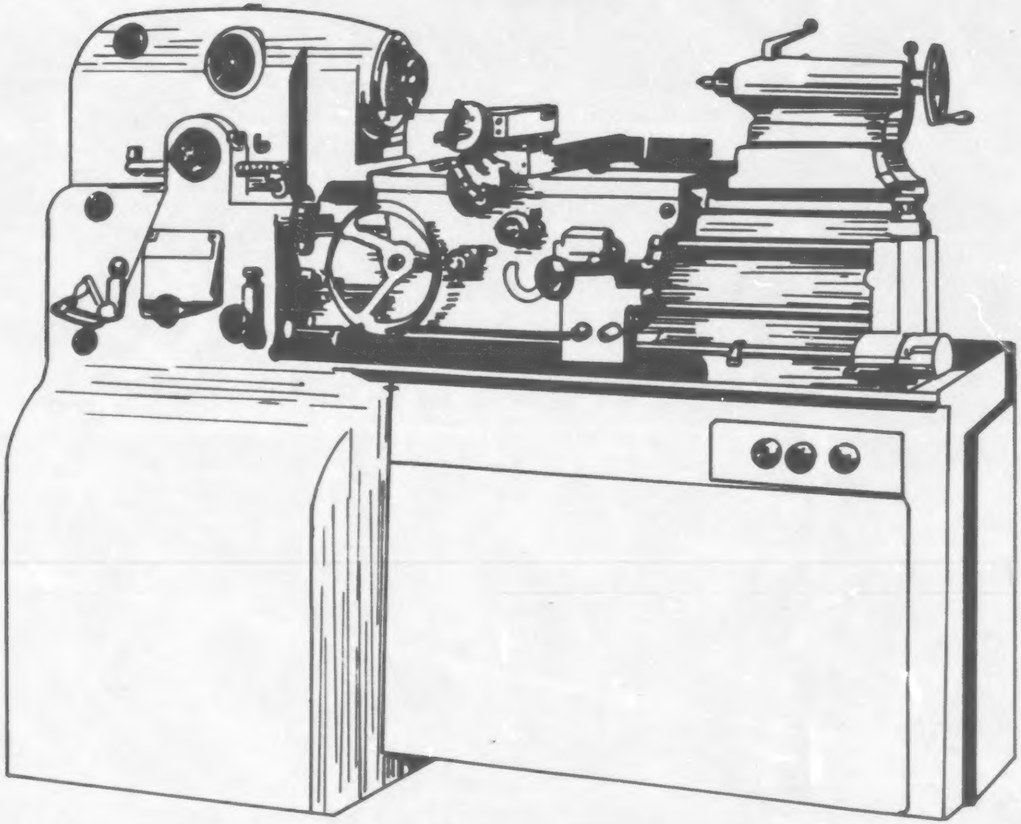
(Continued)



Numerical Control Lathe

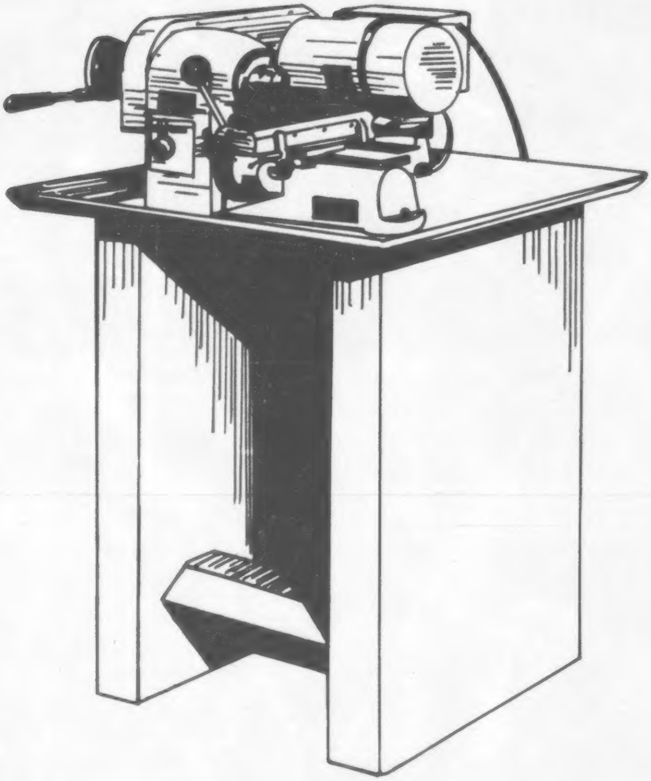
Types of Engine Lathes

(Continued)



Toolroom Lathe

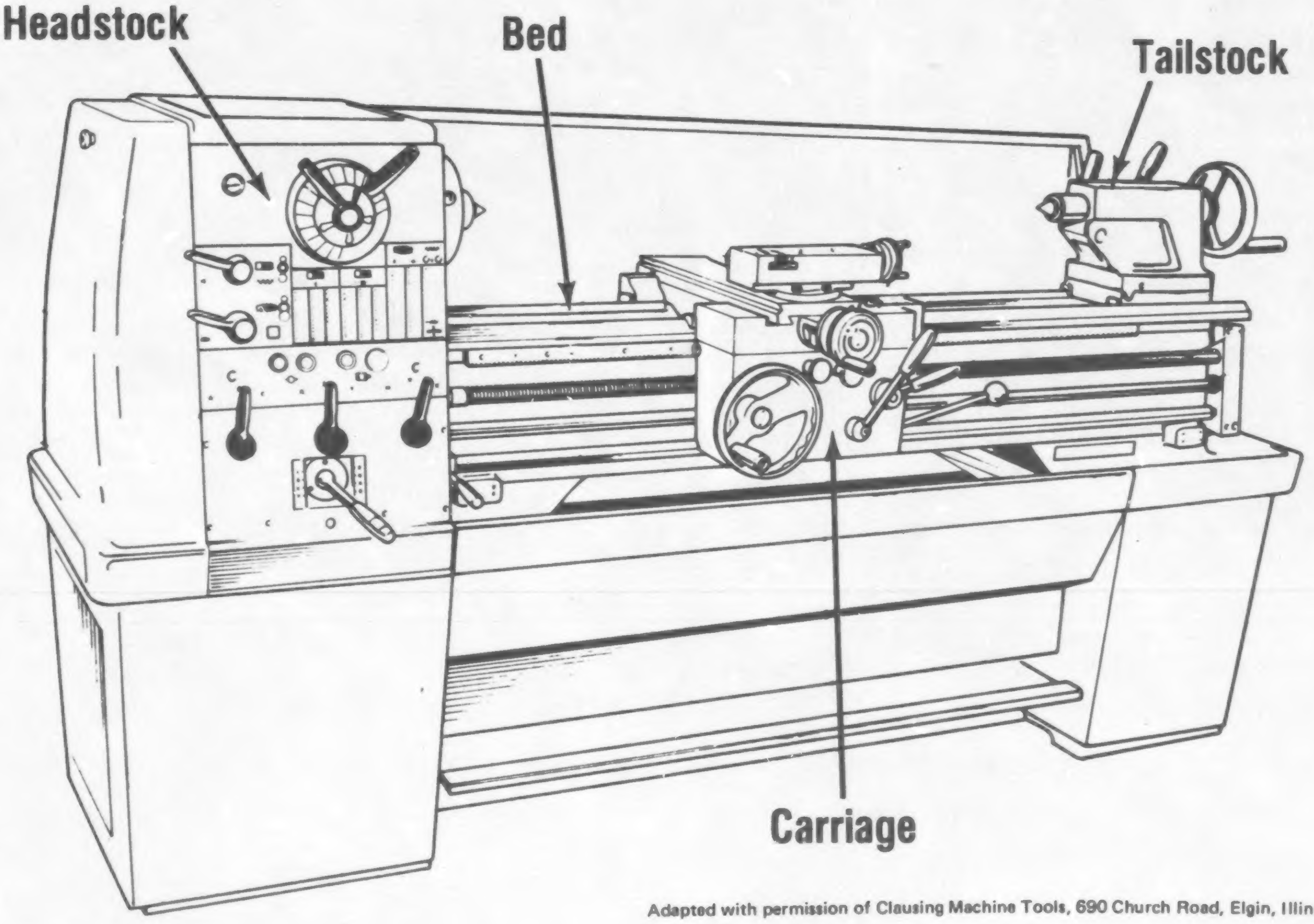
Types of Engine Lathes
(Continued)



Speed Lathe

MS II - 159

Major Parts of an Engine Lathe

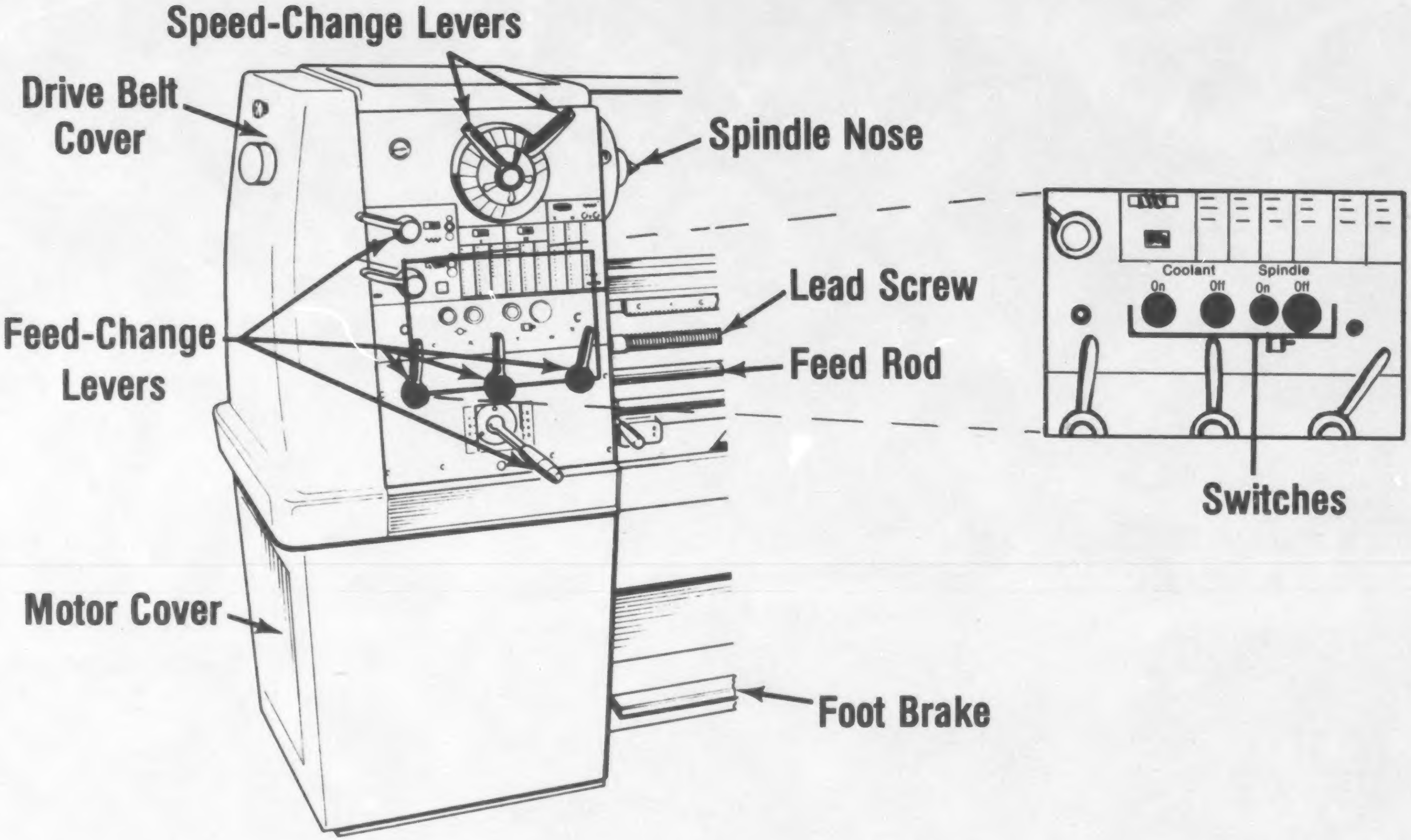

Headstock
Bed
Tailstock
Carriage

Adapted with permission of Clausing Machine Tools, 690 Church Road, Elgin, Illinois 60120.

TM #8

MS II - 161

Lathe Headstock

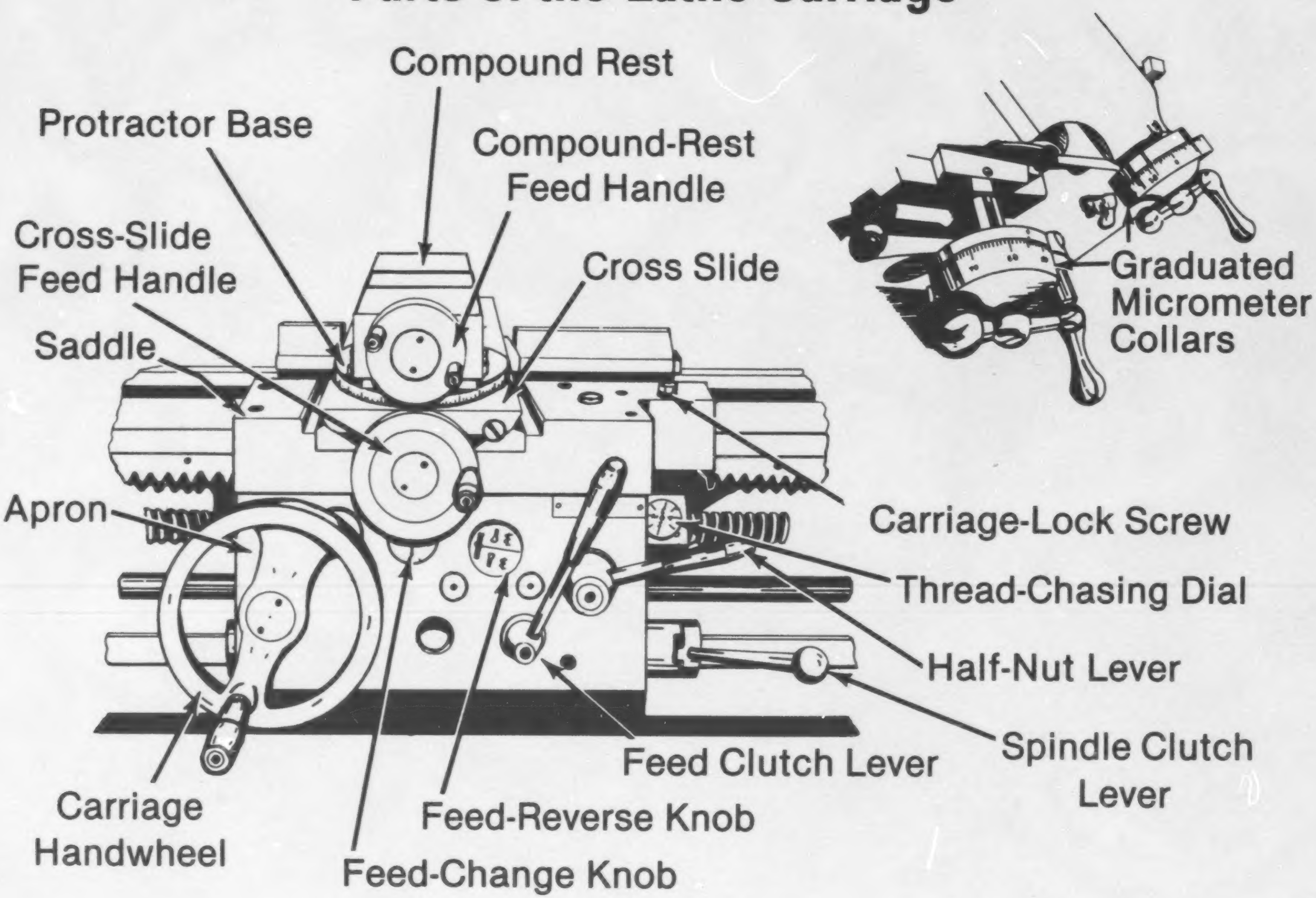

Speed-Change Levers
Drive Belt Cover
Spindle Nose
Lead Screw
Feed Rod
Feed-Change Levers
Coolant
On
Off
Spindle
On
Off
Switches
Motor Cover
Foot Brake

Adapted with permission of Clausing Machine Tools, 690 Church Road, Elgin, Illinois 60120.

TM #9

MS II - 163

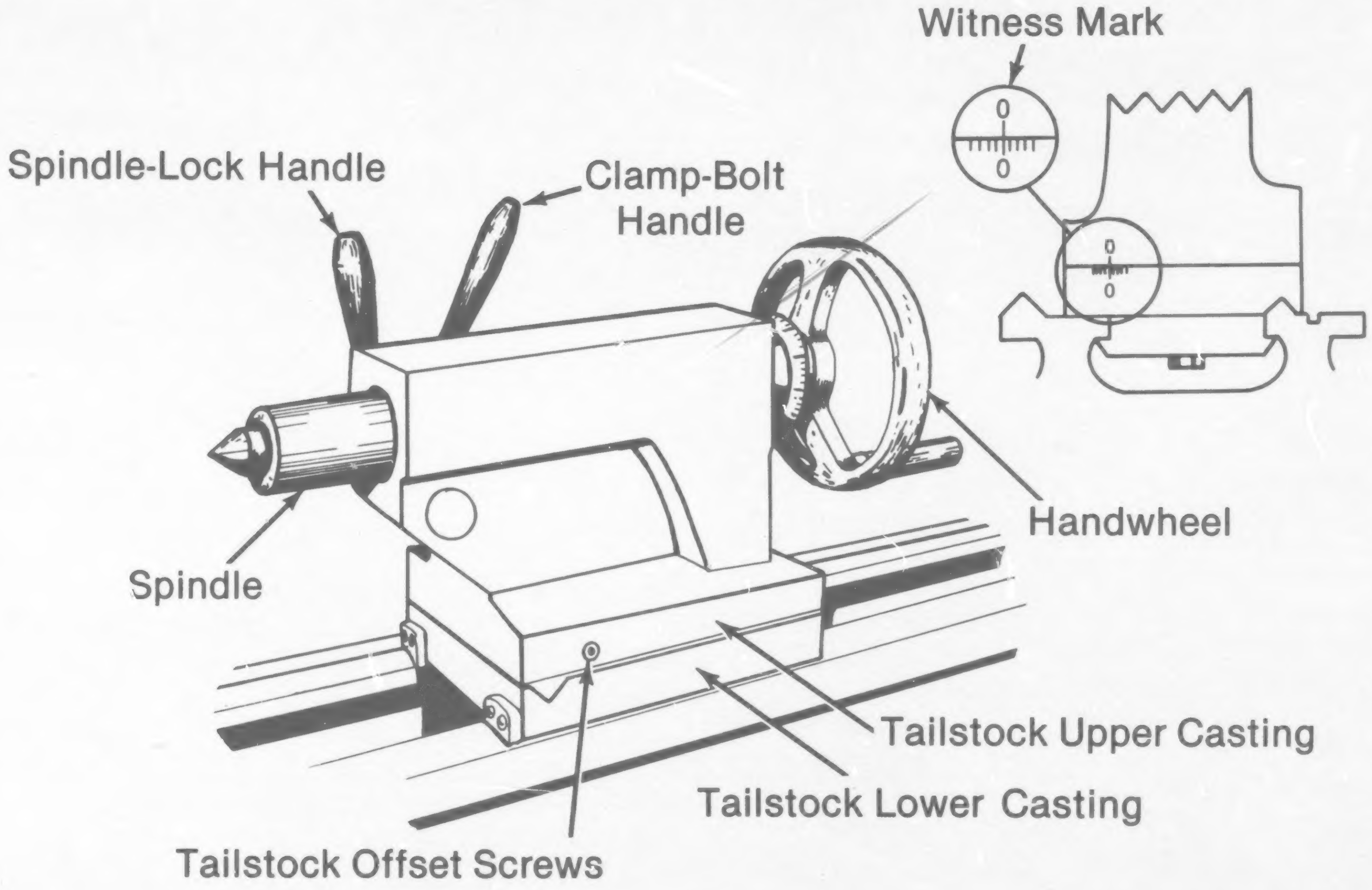
Parts of the Lathe Carriage


Compound Rest
Protractor Base
Compound-Rest Feed Handle
Cross-Slide Feed Handle
Cross Slide
Saddle
Graduated Micrometer Collars
Apron
Carriage-Lock Screw
Thread-Chasing Dial
Half-Nut Lever
Spindle Clutch Lever
Feed Clutch Lever
Carriage Handwheel
Feed-Reverse Knob
Feed-Change Knob

TM #10

MS II - 165

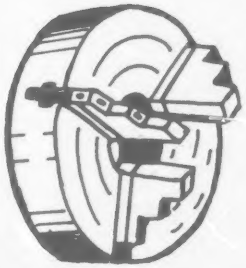
Parts of the Lathe Tailstock


Witness Mark
0
0
0
0
Spindle-Lock Handle
Clamp-Bolt Handle
Handwheel
Spindle
Tailstock Upper Casting
Tailstock Lower Casting
Tailstock Offset Screws

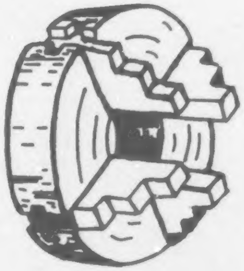
TM #11

MS II - 167

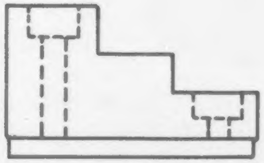
Lathe Accessories



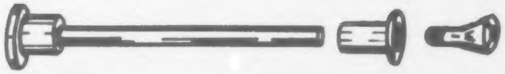
Three-Jaw Universal Chuck



Four-Jaw Independent Chuck

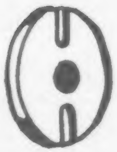


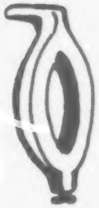
Soft-Jaws for Chuck

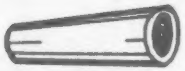


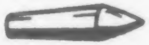
Collet Chuck with Drawbar and Adapter

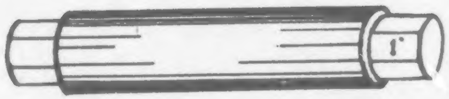
Lathe Accessories
(Continued)

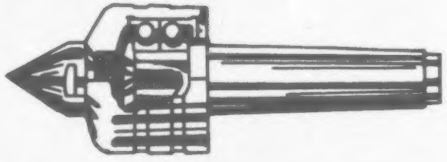

Drive Plate
(Dog Plate)

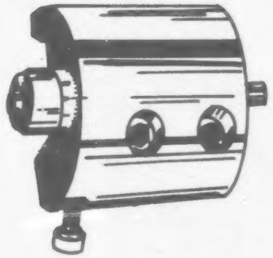

Bent-Tail
Lathe Dog

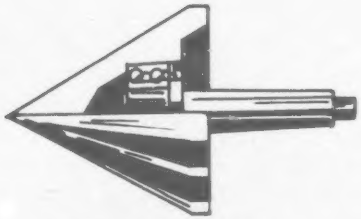

Spindle
Adapter

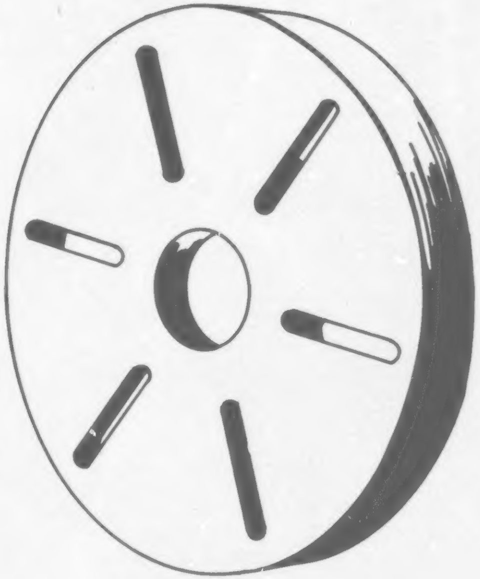

Center


Mandrel


Ball-Bearing Center

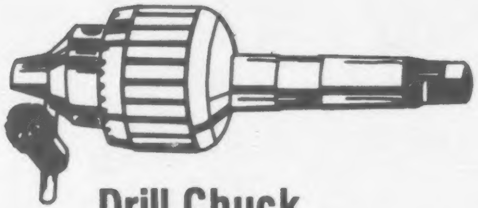

Micrometer
Carriage Stop


Pipe Center

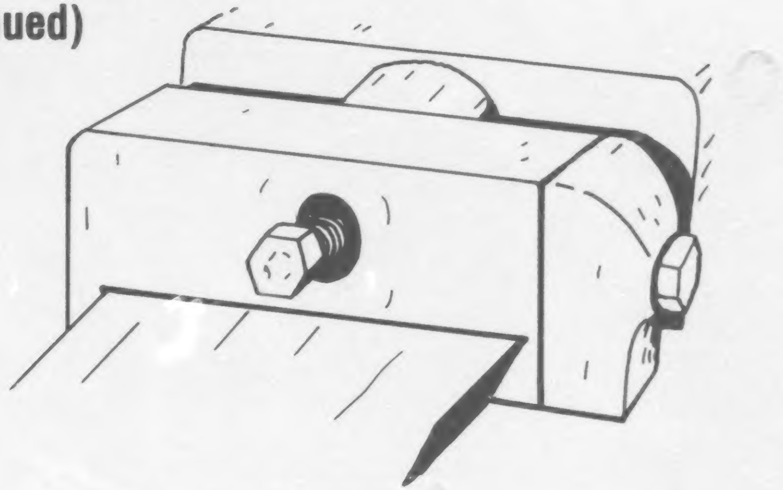

Face Plate

Lathe Accessories

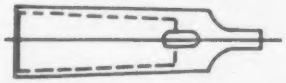
(Continued)



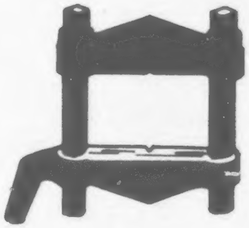
Drill Chuck



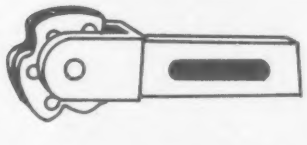
Adjustable Thread-Cutting Stop Travel



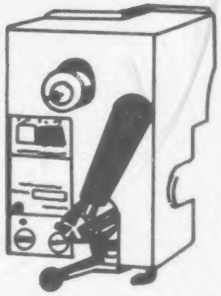
Sleeve Adapter



Clamping Lathe-Dog



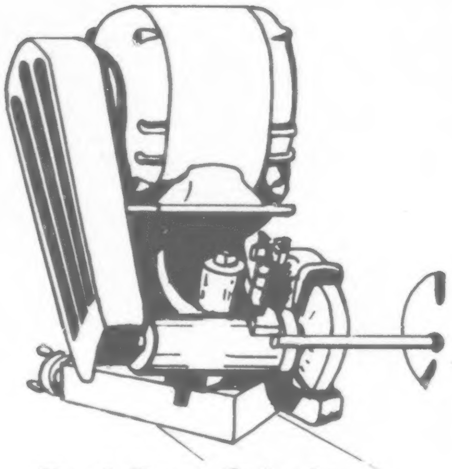
Knurling Tool

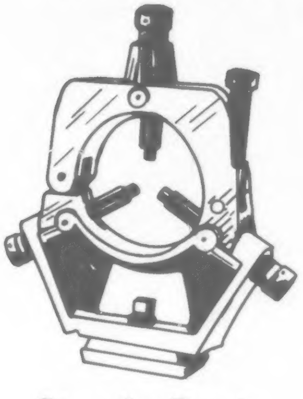


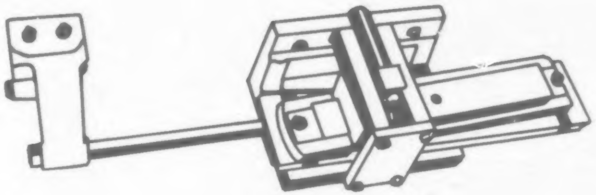
High-Speed
Threading Attachment

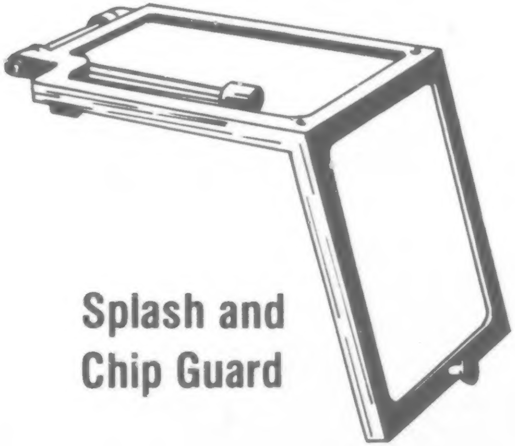
Lathe Accessories

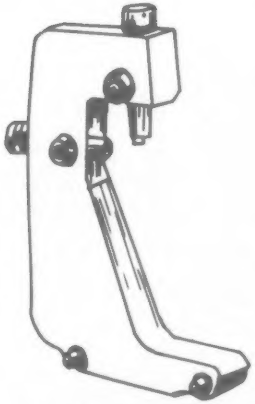
(Continued)

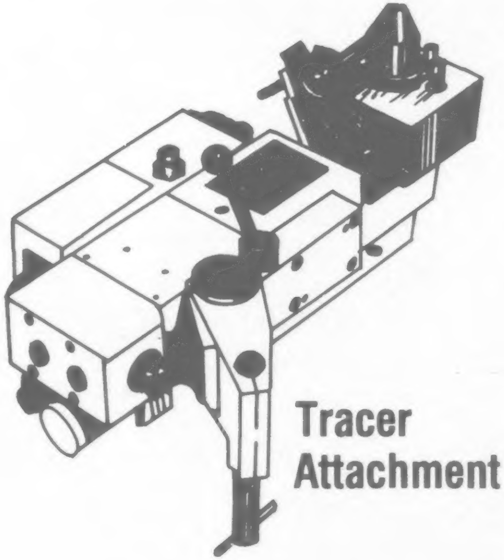

Tool-Post Grinder


Steady Rest

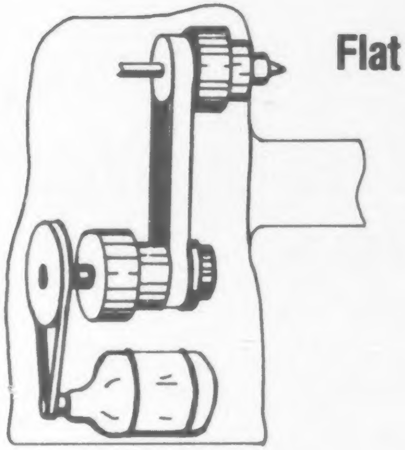

Taper Attachment


Splash and Chip Guard

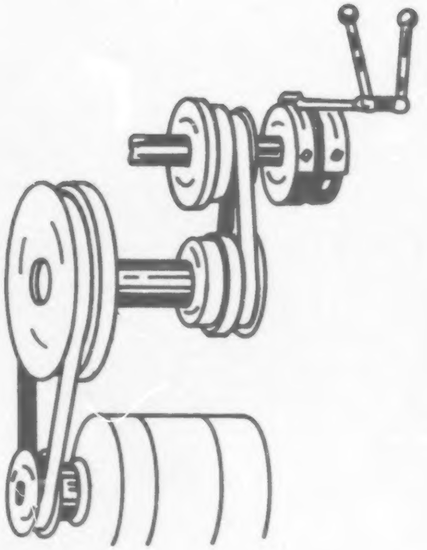

Follower Rest


Tracer Attachment

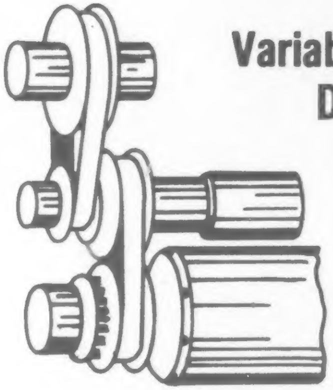
Lathe Spindle Drives



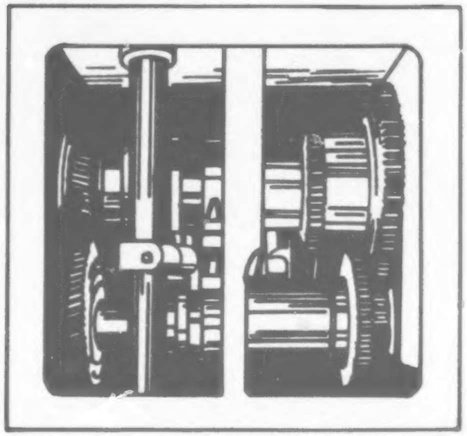
Flat Belt Drive



Manual Shift V-Belt Drive



Variable Pulley Drive



Geared-Head Drive

Bill of Materials

Bill of Materials

Job ____________________

Worker ____________________

Route to ____________________

Job Ordered by ____________________ (Date)

Job Approved by ____________________ (Date)

Job Completed ____________________ (Date)

Part Description, Identification Number, and Blueprint Number	Number Needed	Kind of Material	Material	
			Size	Shape

Stock or Inventory List

Description, Identification Number, and Stock Number (Date) ____________	Maximum Quantity	Minimum Quantity	Quantity to Be Ordered

TM #17

MS II - 179

INTRODUCTION TO LATHES
UNIT II

ASSIGNMENT SHEET #1--DETERMINE LATHE SPEEDS AND FEEDS

NAME________________________ SCORE ____________

To do an effective job of machining, produce the finish required, and preserve maximum tool life, the machinist must ensure that the work turns at the proper rpm to obtain the correct surface feet per minute.

Use the charts following the Information Sheet to determine speeds and feeds for the following operations. For rough turning, use the existing or starting diameter; use the finish size of the part for the finish diameter. Round rpm to the nearest whole number and show all work.

A. Turn a 1 1/2" aluminum bar down to 1 1/8" diameter using high-speed steel cutting tools.

1. Rough turn = ____________ rpm
2. Finish turn = ____________ rpm
3. Rough turn = ____________ ipr
4. Finish turn = ____________ ipr
5. Total amount of material to be removed = ____________

ASSIGNMENT SHEET #1

B. Turn the outside diameter of a 4" hard cast-iron pipe valve to 3.875", using carbide (throw-away) cutting tools.

1. Rough turn = ____________________ rpm
2. Finish turn = ____________________ rpm
3. Rough turn = ____________________ ipr
4. Finish turn = ____________________ ipr
5. Total amount of material to be removed = ______________________

ASSIGNMENT SHEET #1

C. Using a high-speed steel cutting tool, finish turning a brass connector with a diameter of 2.000" to a diameter of 1.950".

1. Finish = ____________________ rpm
2. Feed rate = _________________ ipr
3. Amount of material to be removed with the finish cut = ____________________

ASSIGNMENT SHEET #1

D. Bore a 3 1/2" hole 2 1/2" deep in a 300-series stainless steel bar with an existing hole of 3 1/8" diameter and 3" deep, using a carbide cutting tool.

1. Roughing = ________________ rpm
2. Finishing = ________________ rpm
3. Rough bore at 0.100" deep = ________________ ipr
4. Finish bore at 0.010" deep = ________________ ipr
5. Total amount of material to be bored out = ____________________
6. If two rough cuts and one finish cut are made, how much material will be removed each cut?
   a. First rough cut = ____________________
   b. Second rough cut = ____________________
   c. Finish cut = ____________________

   (NOTE: The total of these three cuts should equal the answer to number 5 of this question.)

ASSIGNMENT SHEET #1

E. Drill a 1 1/4" hole 3" deep in a soft cast-iron bar; the bar is 2 1/2" in diameter. If you drill a pilot hole with a 1/2" diameter first (all drills HSS) . . .

1. What rpm will the work turn when drilling the 1/2" hole?

   rpm = ____________________

2. What rpm will the work turn when drilling the 1 1/4" hole?

   rpm = ____________________

INTRODUCTION TO LATHES
UNIT II

ASSIGNMENT SHEET #2--CALCULATE TIME REQUIRED TO TURN OR BORE WORK

NAME ______________________________ SCORE ______________

Time is money, and when a shop bids on work, all time has been calculated so that cost per part can be set. This requires that speeds, feeds, and depth of cuts be determined correctly.

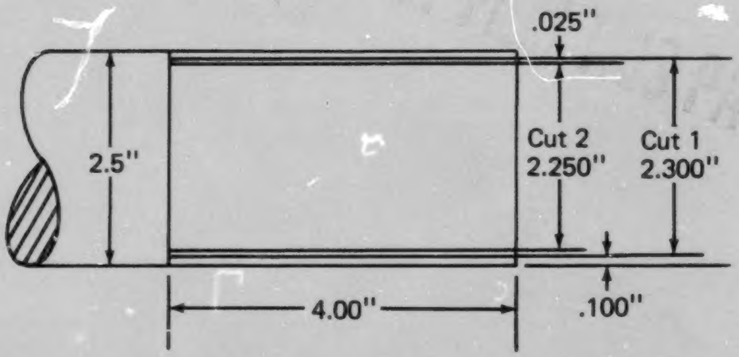
Use the formula below for calculating time to determine how long it will take to perform the following operations. Show the total time required, round answers to the nearest tenth of a minute, and show your work.

$$T = \frac{\text{Length of Cut}}{\text{rpm x Feed}}$$

A. Turn to size a 2 1/2" medium carbon-steel bar (SAE 1030) to 2.250" diameter. Procedure will require one rough cut and one finish cut, using a high-speed steel cutting tool.

Total time = ______________ minutes

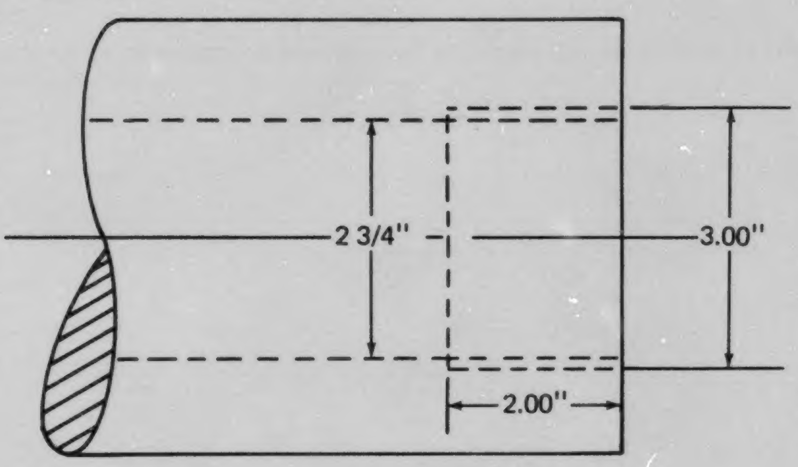
Rough turn--120 rpm
Feed--0.015 ipr
Finish turn--183 rpm
Feed--0.007 ipr



ASSIGNMENT SHEET #2

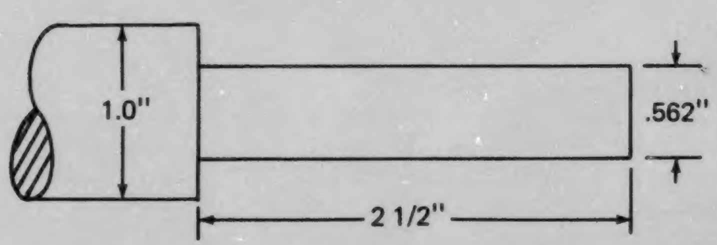
B. Bore a 3" diameter hole 2" deep in work that has a 2 3/4" existing hole. The material is soft cast iron and the boring bar uses carbide inserts. For this operation, use 604 rpm for roughing speed with a feed of 0.010", and 615 rpm for finishing with a feed of 0.008". This operation will require two rough cuts and one finish cut.

Total time = ____________________ minutes



C. Turn a 1" aluminum bar down to 9/16" using high-speed steel cutting tools; use 2000 rpm with a 0.015" feed for roughing, and 2000 rpm with a 0.007" feed for finishing. The total material to be removed is 0.438", which will require two rough cuts and one finish cut.

Total time = ____________________ minutes



INTRODUCTION TO LATHES
UNIT II

ASSIGNMENT SHEET #3--COMPLETE SAFETY TEST FOR ENGINE LATHE OPERATIONS

NAME ______________________________ SCORE ____________

(NOTE: A score of 100 percent is the minimum acceptable score for this assignment sheet.)

Safe practices are a must when operating turning equipment. Industry demands that operators observe all safety practices. Time lost due to accidents and damaged equipment is costly.

Complete the rules for each of the following. Do not refer to your Information Sheet.

A. __________ __________ with __________ __________ must be worn in shop area

B. ____________________ and ____________________ must be removed before operating machinery

C. Wear ____________ ____________ clothes with shirttail tucked into pants; roll up long sleeves past elbow, or button

D. ________________ is strictly prohibited in shop area

E. The lathe should be ________________ before measuring, adjusting, cleaning, or oiling

F. Never use ______________ to try to stop lathe spindle or chuck, to grab chips, or to remove hot work from work-holding device

G. _______________ should never be used around revolving or moving parts

H. Never operate a machine with ________________ removed

I. The _______________ must be removed immediately; it should never be left in chuck

J. The _______________ should be kept clean and free of chips and oil to eliminate slipping and tripping hazards

K. Always check ____________ ____________ to make sure that they are mounted securely

L. Never leave ____________ lying on machine

M. Always clean ____________ before mounting on spindle; never set directly on the ways

ASSIGNMENT SHEET #3

N. Large or ______________ - ______________ parts that are chucked should be rotated one complete revolution by hand to make sure jaws and work clear ways and carriage

O. All sharp edges and burrs must be ______________ from work

INTRODUCTION TO LATHES
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

A.
1. 1600 rpm
2. 2844 rpm
3. 0.015 ipr
4. 0.007 ipr
5. 0.375"

B.
1. 340 rpm
2. 423 rpm
3. 0.015 ipr
4. 0.007 ipr
5. 0.125"

C.
1. 985 rpm
2. 0.007 ipr
3. 0.050"

D.
1. 460 rpm
2. 457 rpm
3. 0.010 ipr
4. 0.006 ipr
5. 0.375"
6. a. 0.178" or 0.200"
   b. 0.177" or 0.155"
   c. 0.020"

E.
1. 1280 rpm
2. 512 rpm

Assignment Sheet #2

A. 5.3 minutes

B. 1.1 minutes

C. 0.4 minute

Assignment Sheet #3

A. Safety glasses; side shields

B. Watches; rings

C. Close-fitting

D. Horseplay

ANSWERS TO ASSIGNMENT SHEETS

E. Stopped

F. Hands

G. Rags

H. Guards

I. Chuck wrench

J. Floor

K. Work-holding devices

L. Tools

M. Chuck

N. Oddly shaped

O. Removed

INTRODUCTION TO LATHES
UNIT II

JOB SHEET #1--FREE-HAND GRIND A TURNING TOOL

I. Equipment and materials

- A. Steel keystock, 3/8" square, 3" long
- B. High-speed tool blank, 3/8" square
- C. Pedestal grinder
- D. Goggles
- E. Grinding wheel dresser
- F. Oilstone

II. Procedure (Figure 52)

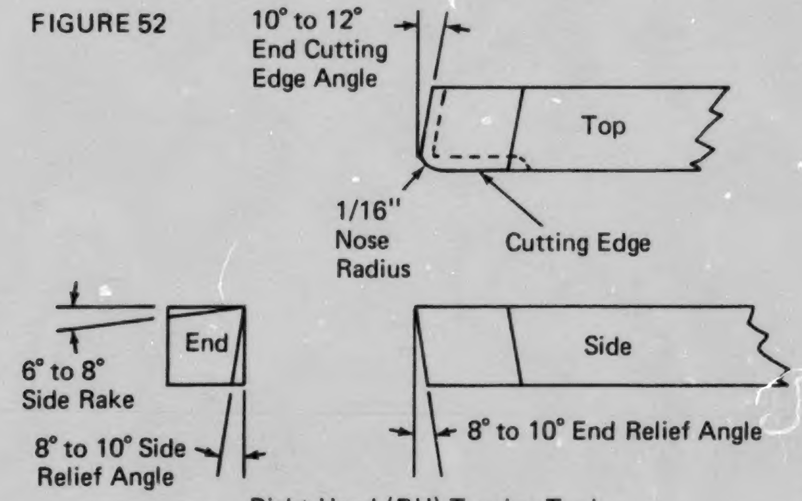
- A. Prepare for grinding

  (CAUTION: Use goggles at all times to protect eyes from grinding dust.)

  1. Dress both coarse and fine-grit aluminum oxide grinding wheels if required
  2. Adjust tool rest and spark breakers if necessary

  (CAUTION: Never make adjustments until grinding wheel has stopped.)

FIGURE 52


10° to 12° End Cutting Edge Angle
Top
1/16" Nose Radius
Cutting Edge
End
6° to 8° Side Rake
8° to 10° Side Relief Angle
Side
8° to 10° End Relief Angle

Right-Hand (RH) Turning Tool

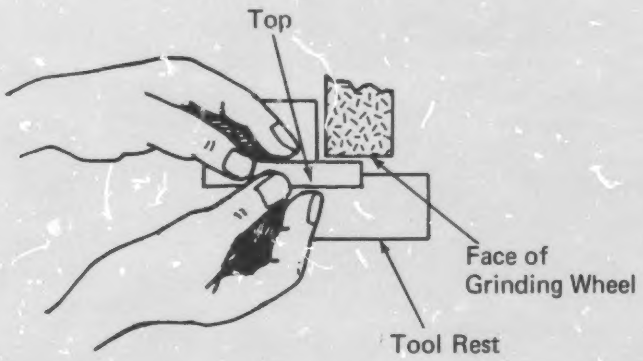
JOB SHEET #1

B. Grind cutting edge and side relief angle

(NOTE: Use keystock first to practice the procedure.)

1. Hold tool with fingers and thumbs of both hands, and place tool so that left side is parallel to face of coarse grinding wheel (Figure 53)

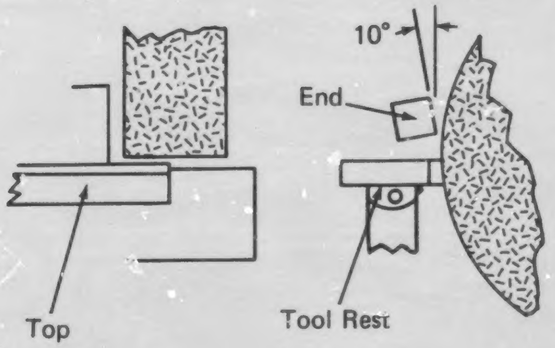
FIGURE 53


Top
Face of Grinding Wheel
Tool Rest

2. Tilt top of tool away from wheel about 10°; bring tool into contact with wheel and grind side relief angle and cutting edge at same time (Figure 54)

(NOTE: Make cutting edge about the width of the tool.)

FIGURE 54


10°
End
Top
Tool Rest

JOB SHEET #1

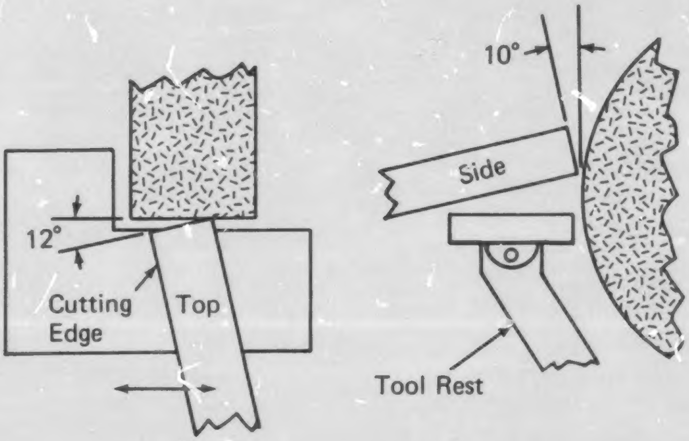
3. Continue to grind until side relief angle blends with cutting edge at top of tool

   (NOTE: Do not allow the tool to overheat.)

C. Grind end cutting edge and end relief angles

1. Position tool so that end of tool is at about a 12° angle to face of wheel with cutting edge side away from wheel; tilt end of tool up about 10° so that you will produce end relief angle at the same time (Figure 55)

FIGURE 55



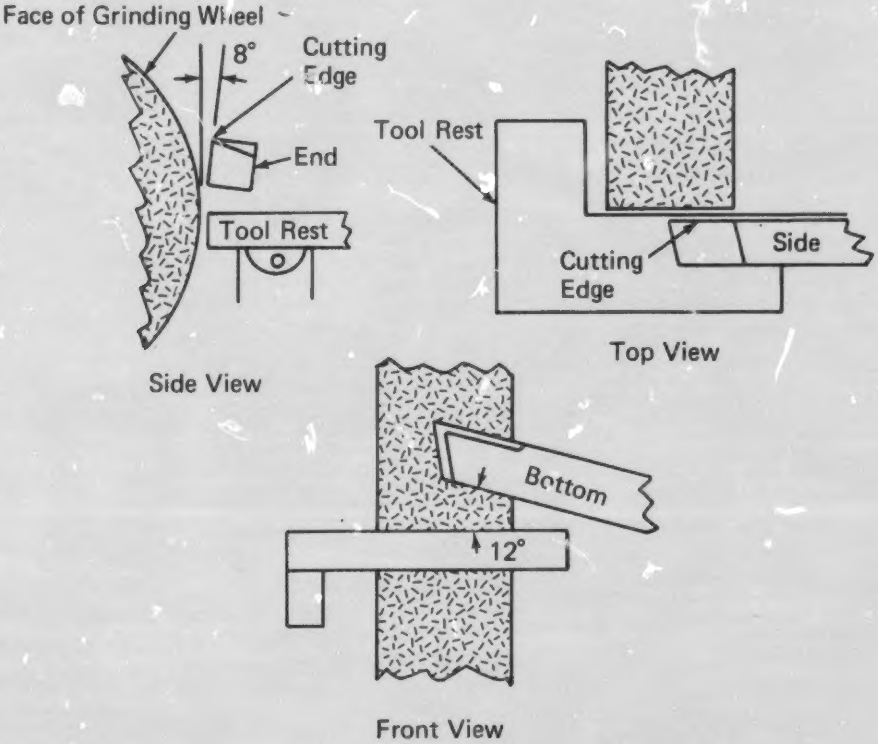
2. Bring tool into contact with wheel; grind end relief angle until it has reached top of tool, forming the end cutting edge angle

JOB SHEET #1

D. Grind side and back rake angles

1. Hold top of tool parallel to face of wheel so that cutting edge is up; tilt point of tool up about 12°, and tilt cutting edge about 8° away from grinding wheel (Figure 56)

FIGURE 56



Face of Grinding Wheel
8°
Cutting Edge
End
Tool Rest
Side View
Tool Rest
Side
Cutting Edge
Top View
Bottom
12°
Front View

2. Bring tool into contact with grinding wheel, and grind side rake angle until it reaches cutting edge

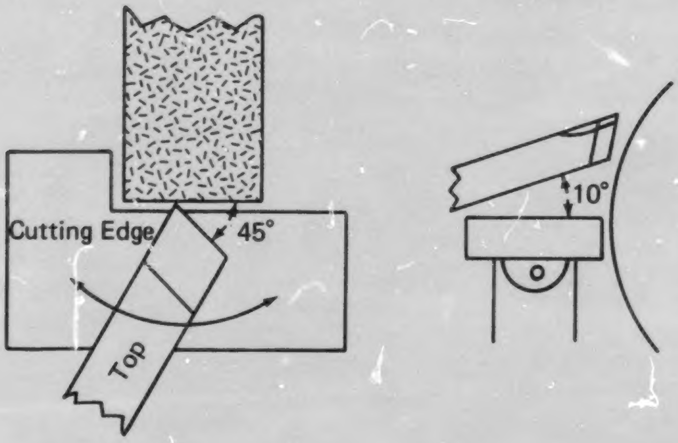
(NOTE: This tool has a neutral back rake angle. To grind a positive or negative angle, tilt the point either toward or away from the grinding wheel.)

JOB SHEET #1

E. Grind nose radius

1. Hold end of tool at about a 45° angle to face of wheel, with cutting edge toward wheel; tilt point up about 10° (Figure 57)

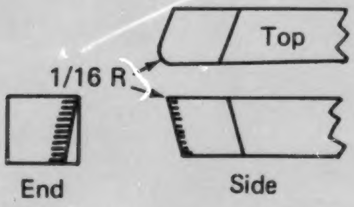
FIGURE 57



2. Bring tool in to wheel and rotate point between side cutting edge and end cutting edge until you have ground the 1/16" radius (Figure 58)

(NOTE: The nose radius must follow the nose clearance to maintain the clearance angle.)

FIGURE 58



F. Repeat steps A-E using the fine-grit wheel to produce finished surface

G. Hone cutting edges of tool bit slightly with an oilstone to remove wire edges; hold tool, and work stone across cutting edges

H. When you are confident with the procedure, grind the tool using the high-speed steel blank

INTRODUCTION TO LATHES
UNIT II

JOB SHEET #2--FREE-HAND GRIND A FACING TOOL

I. Equipment and materials

- A. Steel keystock, 3/8" square, 3" long
- B. High-speed steel tool blank, 3/8" square
- C. Pedestal grinder
- D. Goggles
- E. Grinding wheel dresser
- F. Oilstone

II. Procedure (Figure 59)

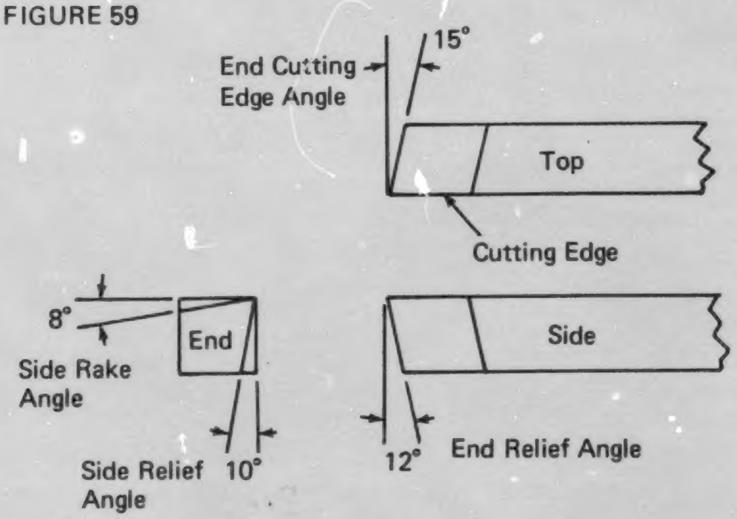
- A. Prepare for grinding

  (CAUTION: Use goggles at all times to protect eyes from grinding dust.)

  1. Dress both coarse and fine-grit aluminum oxide grinding wheels if required
  2. Adjust tool rests and spark breakers if necessary

  (CAUTION: Never make adjustments until grinding wheel has stopped.)

FIGURE 59


15°
End Cutting Edge Angle
Top
Cutting Edge
8°
Side Rake Angle
End
Side Relief Angle
10°
Side
12°
End Relief Angle

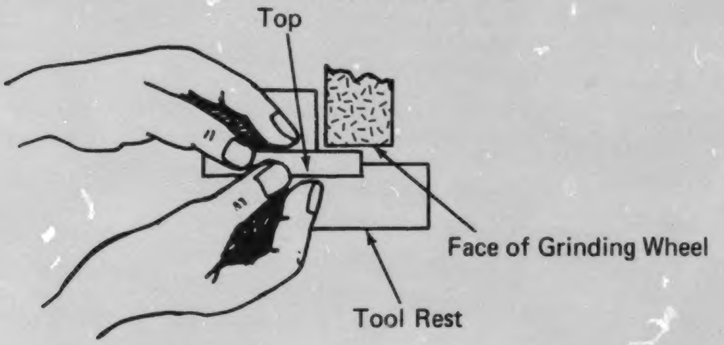
JOB SHEET #2

B. Grind cutting edge and side relief angle

(NOTE: Use keystock first to practice the procedure.)

1. Hold tool with fingers and thumbs of both hands, and place tool so that left side is parallel to face of coarse grinding wheel (Figure 60)

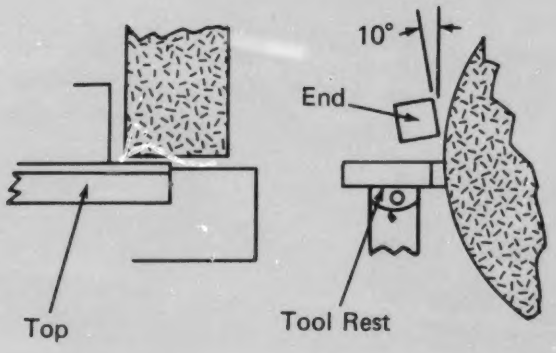
FIGURE 60


Top
Face of Grinding Wheel
Tool Rest

2. Tilt top of tool away from wheel about 10°; bring tool in contact with wheel and grind side clearance angle and cutting edge at same time (Figure 61)

(NOTE: Make cutting edge about the width of the tool.)

FIGURE 61


10°
End
Top
Tool Rest

JOB SHEET #2

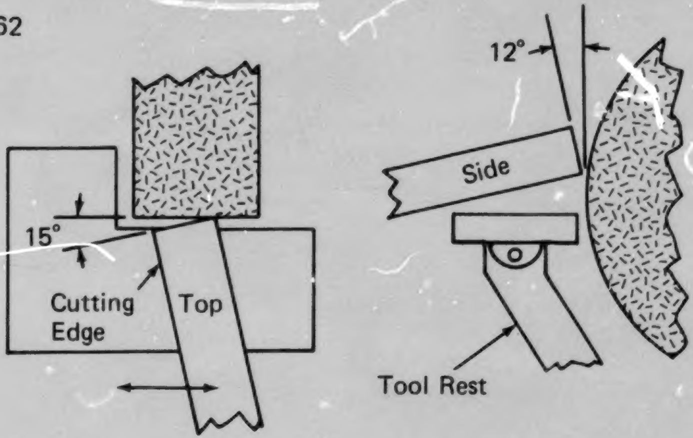
3. Continue grinding until side relief angle blends with cutting edge

   (NOTE: Do not allow the tool to overheat.)

C. Grind end cutting edge and end relief angles

1. Position tool so that end of tool is at about a 15° angle to face of wheel, with cutting edge away from wheel; tilt end of tool up about 12° so that you will produce end relief angle at same time (Figure 62)

FIGURE 62

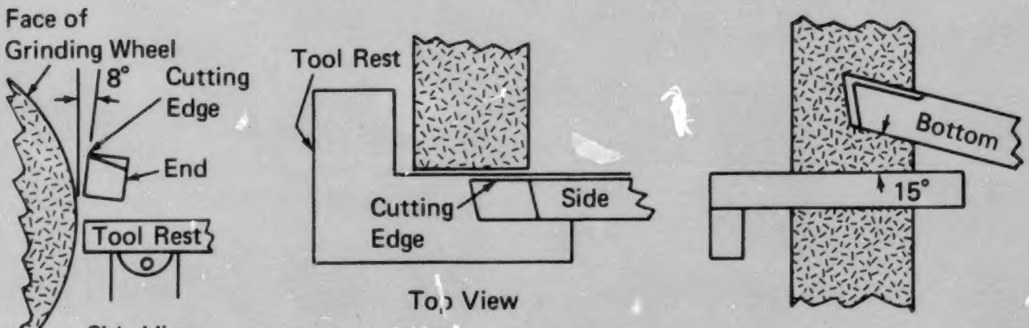

15°
Cutting Edge
Top
12°
Side
Tool Rest

2. Bring tool into contact with wheel; grind end relief angle until it has reached top of tool, forming the end cutting edge angle

D. Grind side and back rake angles

1. Hold top of cutting tool parallel to face of wheel so that cutting edge is up; tilt point of the tool up about 15°, and tilt cutting edge about 8° away from grinding wheel (Figure 63)

FIGURE 63


Face of Grinding Wheel
8°
Cutting Edge
End
Tool Rest
Tool Rest
Cutting Edge
Side
Bottom
15°

Side View

Top View

Front View

JOB SHEET #2

2. Bring the tool into contact with grinding wheel, and grind side rake angle until it reaches cutting edge

   (NOTE: This tool has a neutral back rake angle. To grind a positive or negative angle, tilt the point either toward or away from the grinding wheel.)

E. Repeat steps A-D with the fine-grit wheel to produce finished surfaces

F. Hone cutting edges of tool bit slightly with an oilstone to remove wire edges; hold tool, and work stone across cutting edges

G. When you are confident with the procedure, grind the tool using the high-speed steel blank

INTRODUCTION TO LATHES
UNIT II

JOB SHEET #3--FREE-HAND GRIND A 60° THREADING TOOL

I. Equipment and materials

- A. Steel keystock, 3/8" square, 3" long
- B. High-speed tool blank, 3/8" square
- C. Pedestal grinder
- D. Goggles
- E. Grinding wheel dresser
- F. Center gauge
- G. Oilstone

II. Procedure (Figure 64)

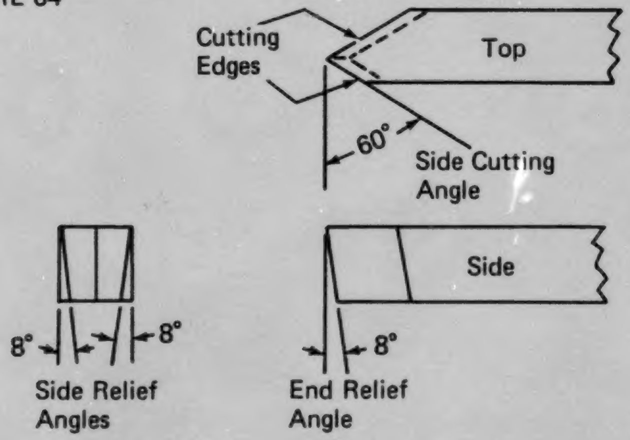
- A. Prepare for grinding

  (CAUTION: Use goggles at all times to protect eyes from grinding dust.)

  1. Dress both coarse and fine-grit aluminum oxide grinding wheels if required
  2. Adjust tool rests and spark breakers if necessary

     (CAUTION: Never make adjustments until grinding wheel has stopped.)

FIGURE 64


Cutting Edges
Top
60°
Side Cutting Angle
Side
8°
8°
Side Relief Angles
8°
End Relief Angle

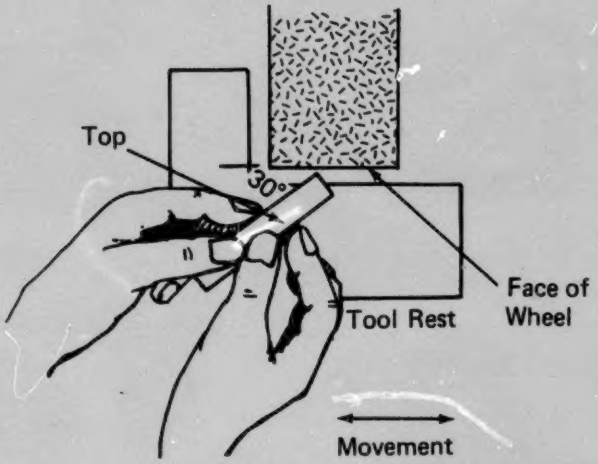
JOB SHEET #3

B. Grind left cutting edge and side relief angles

(NOTE: Use keystock first to practice the procedure.)

1. Hold tool with fingers and thumbs of both hands, and place tool so that left side is at about a 30° angle to face of coarse grinding wheel (Figure 65)

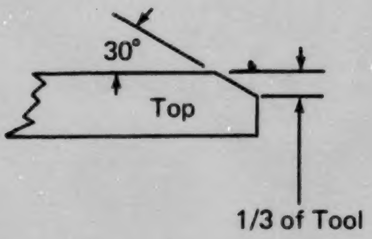
FIGURE 65



2. Tilt top of tool away from grinding wheel about 8°; bring tool into contact with wheel and grind left side cutting angle and side relief angle at the same time; continue grinding until about one-third of the tool end has been ground (Figure 66)

   (NOTE: Do not allow the tool to overheat.)

FIGURE 66

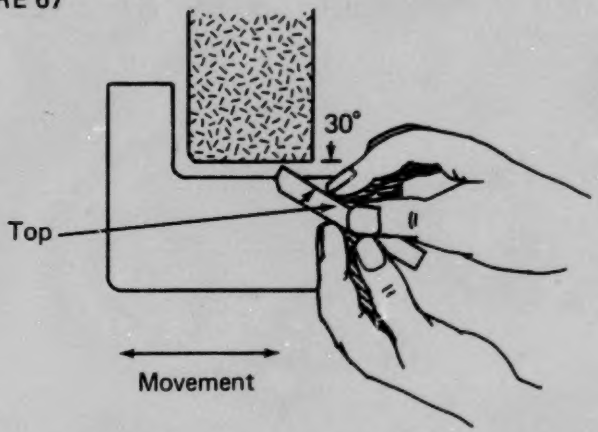


JOB SHEET #3

C. Grind right cutting edge and side relief angle

1. Turn tool so that right side is at about a 30° angle to face of wheel (Figure 67); tilt top of tool away from wheel about 8°

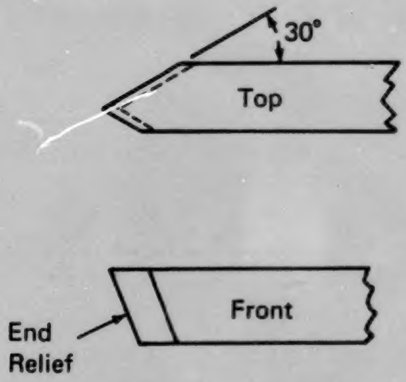
FIGURE 67



2. Bring tool into contact with wheel; grind until right side cutting angle forms a point with left side cutting angle (Figure 68)

(NOTE: The end relief angle was formed by grinding the side relief on the left and right sides of the tool.)

FIGURE 68

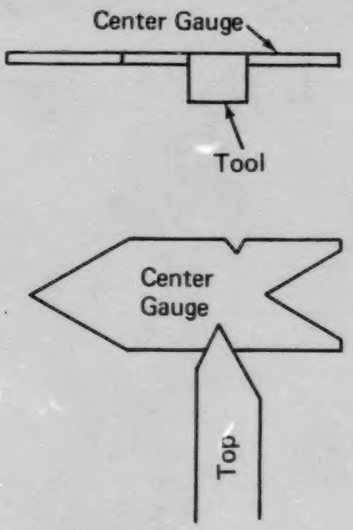


JOB SHEET #3

D. Check the 60° angle

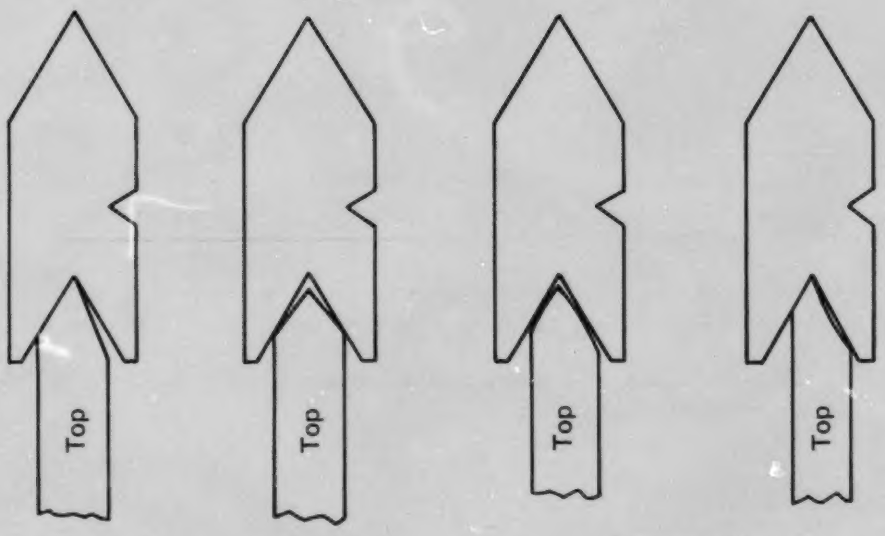
1. Insert point of tool into deeper "V" on side of center gauge; hold top of tool flush with center gauge (Figure 69)

FIGURE 69


Center Gauge
Tool
Center Gauge
Top

2. With tool in gauge, hold it toward a light to see if tool fits accurately (Figure 70)

FIGURE 70


Top
Top
Top
Top

Angle of Tool Less than 60°

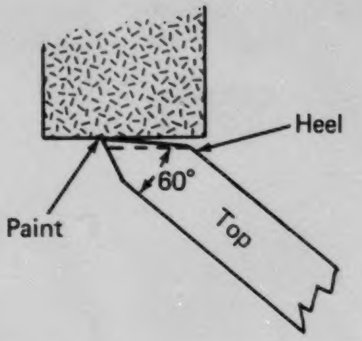
Angle of Tool Greater than 60°

One or Both Sides Not Straight

JOB SHEET #3

3. If angle is less than 60°, hold point to wheel and grind until blended into side (Figure 71)

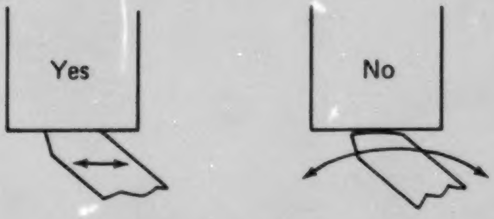
FIGURE 71



4. If angle is greater than 60°, reduce angle by grinding at heel, until blended into point

5. If sides are not straight, redress grinding wheel and move tool across wheel in a straight line, not in an arc (Figure 72)

FIGURE 72



6. Continue grinding and checking with center gauge until tool fits gauge

E. Repeat steps A-D with fine-grit wheel to produce finished surfaces

F. Hone cutting edges of tool slightly with an oilstone to remove wire edges; hold tool, and work stone across cutting edges

G. When you are confident with the procedure, grind the tool using the high-speed steel blank

INTRODUCTION TO LATHES
UNIT II

JOB SHEET #4--FREE-HAND GRIND A SQUARE-NOSE TOOL

I. Equipment and materials

   A. Steel keystock, 3/8" square, 3" long

   B. High-speed steel tool blank, 3/8" square

   C. Pedestal grinder

   D. Goggles

   E. Grinding wheel dresser

   F. Oilstone

II. Procedure (Figure 73)

   A. Prepare for grinding

   (CAUTION: Use goggles at all times to protect eyes from grinding dust.)

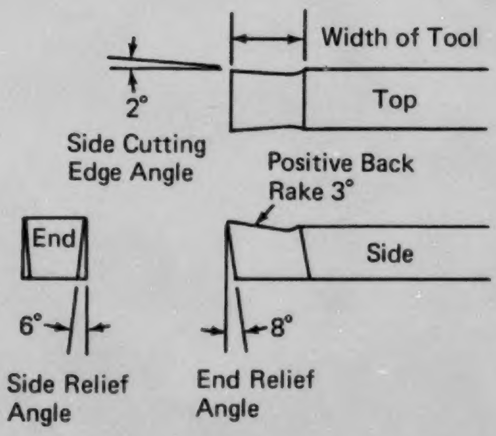
   1. Dress both coarse and fine-grit aluminum oxide grinding wheels if required

   2. Adjust tool rest and spark breakers if necessary

   (CAUTION: Never make adjustments until grinding wheel has stopped.)

FIGURE 73

Square-Nose Tool


Width of Tool
2°
Top
Side Cutting Edge Angle
Positive Back Rake 3°
End
Side
6°
8°
Side Relief Angle
End Relief Angle

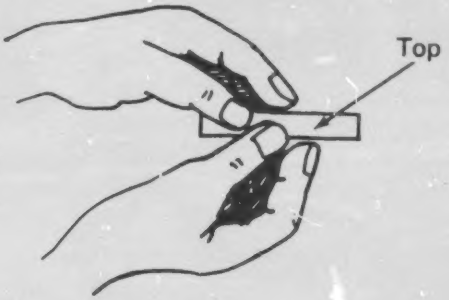
JOB SHEET #4

B. Grind side cutting edges, side cutting-edge angles, and side relief angles

(NOTE: Use keystock for practice.)

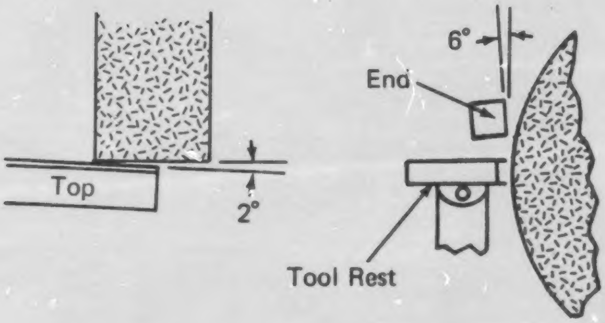
1. Hold tool with fingers and thumbs of both hands (Figure 74)

FIGURE 74



2. Position tool so that face of coarse grinding wheel will cut into left side of tool at about a 2° angle; then tilt top of tool away from wheel about 6° (Figure 75)

FIGURE 75



3. Bring tool into contact with wheel, and grind cutting edge angles and side relief angles at same time

(NOTE: The cutting edge should be about the width of the tool.)

4. Continue to grind these angles until side relief angle reaches top of tool to form side cutting edge

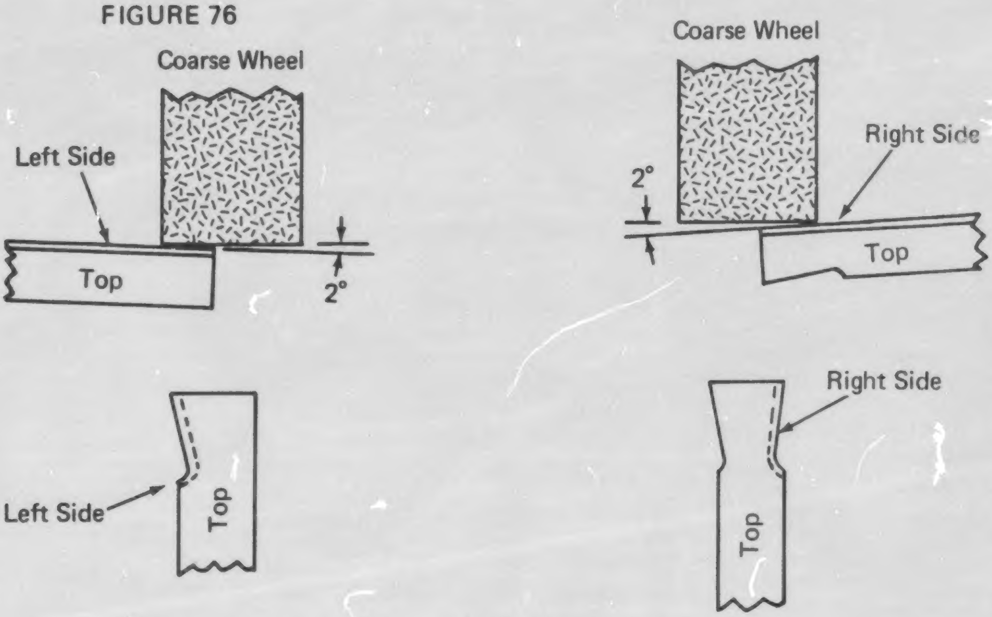
(NOTE: Do not allow the tool to overheat.)

JOB SHEET #4

5. Turn tool and grind side cutting-edge angle and side relief angle on right side of tool; use same procedure used for left side

   (NOTE: The tool will be on the other side of the grinding wheel. See Figure 76.)

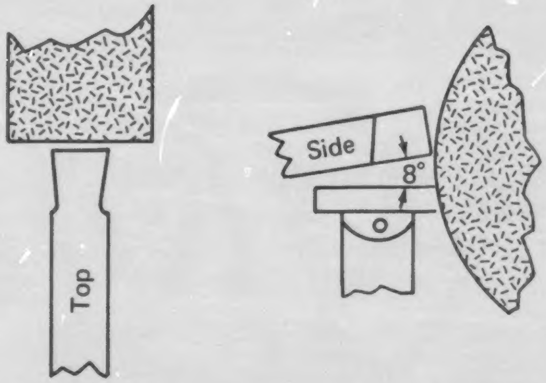
FIGURE 76


Coarse Wheel
Left Side
Top
2°
Coarse Wheel
Right Side
2°
Top
Left Side
Top
Right Side
Top

C. Grind end cutting edge and end relief angle

1. Hold tool so that end is square to face of grinding wheel; tilt end up about 8° (Figure 77)

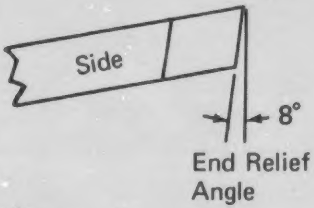
FIGURE 77



JOB SHEET #4

2. Bring tool into contact with grinding wheel; continue to grind end relief angle until it reaches top of tool to form end cutting edge (Figure 78)

FIGURE 78

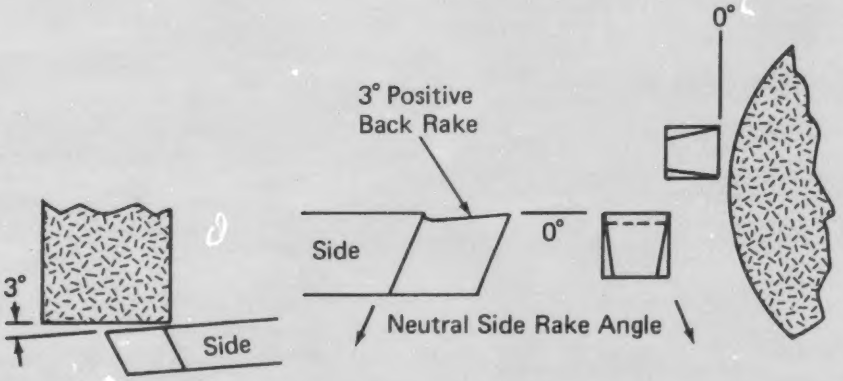


D. Grind back rake angle

1. Hold top of tool so that tool is parallel to face of wheel, with cutting edge up; turn tool so that end cutting edge is about 3° away from face of wheel (Figure 79)

2. Bring the tool into contact with wheel, and grind back rake angle

FIGURE 79



3. Continue to grind until back rake angle reaches end of tool (end cutting edge)

E. Repeat steps A-D with fine-grit wheel to produce finished surfaces

F. Hone cutting edges of tool bit slightly with an oilstone to remove wire edges; hold tool, and work stone across cutting edges

G. When you are confident with the procedure, grind the tool using the high-speed steel blank

INTRODUCTION TO LATHES
UNIT II

JOB SHEET #5--SHARPEN A CUTOFF TOOL BLADE

I. Equipment and materials

- A. Cutoff blade
- B. Pedestal grinder
- C. Goggles
- D. Grinding wheel dresser
- E. Oilstone

II. Procedure (Figure 80)

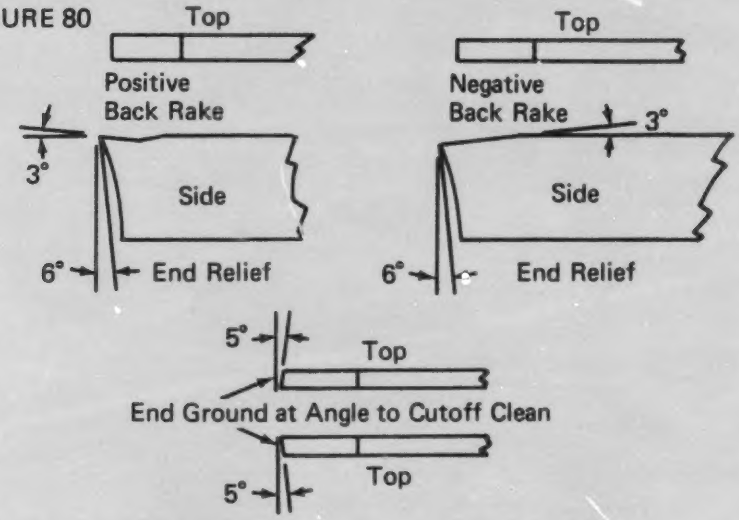
A. Prepare for grinding

(CAUTION: Use goggles at all times to protect eyes from grinding dust.)

1. Dress both coarse and fine-grit aluminum oxide grinding wheels if required
2. Adjust tool rest and spark breakers if necessary

(CAUTION: Never make adjustments until wheel has stopped.)

FIGURE 80


Top
Positive
Back Rake
3°
Side
6°
End Relief
Top
Negative
Back Rake
3°
Side
6°
End Relief
5°
Top
End Ground at Angle to Cutoff Clean
Top
5°

(NOTE: Cutoff blades may use either a positive or negative back rake angle. Many cutoff blades also have an end cutting-edge angle to permit cleaner breaks in the cut material.)

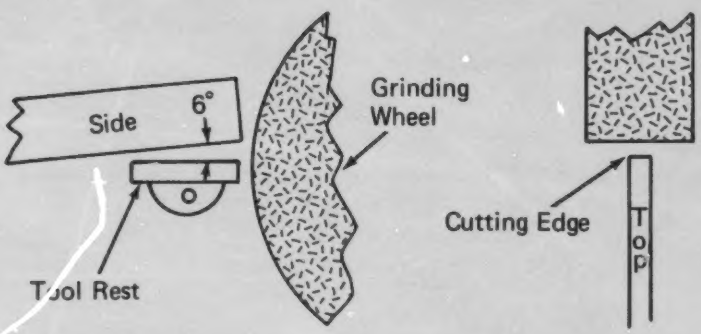
JOB SHEET #5

B. Grind end relief and end cutting-edge angle

1. Hold tool so that end is parallel to face of coarse grinding wheel; tilt end up about 6°

   (NOTE: The end cutting edge may be flat as in Figure 81, or it may be ground at an angle as in Figure 82. Whichever design is used, the edge should be held parallel to the wheel as shown.)

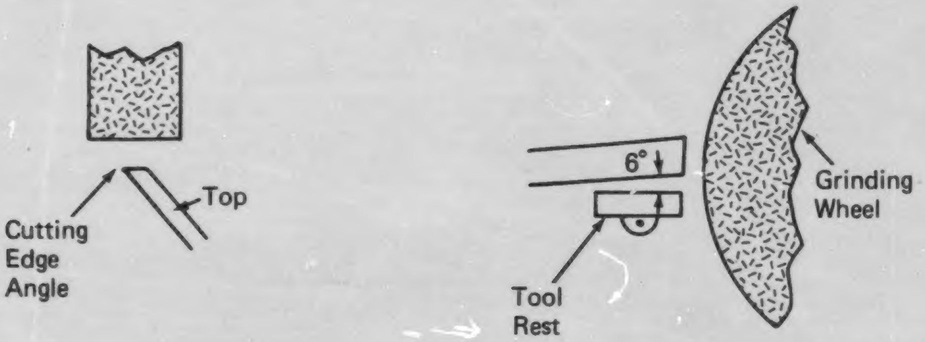
FIGURE 81


Side
6°
Grinding Wheel
Tool Rest
Cutting Edge
Top

2. Bring tool in contact with wheel, and grind end relief angle until it reaches top

   (NOTE: Do not allow the tool to overheat.)

FIGURE 82


Cutting Edge Angle
Top
6°
Grinding Wheel
Tool Rest

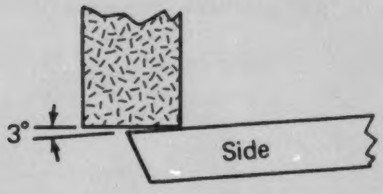
JOB SHEET #5

C. Grind back rake angle

1. For a positive back rake

   a. Hold top of tool at a 3° angle to face of wheel, with edge away from wheel (Figure 83)

FIGURE 83

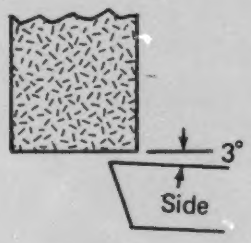


   b. Bring tool into contact with wheel and grind until back rake reaches end; back rake length should be about same as width of the tool

2. For a negative back rake

   a. Hold top of the tool at a 3° angle to face of wheel, so that end cutting edge is toward wheel (Figure 84)

FIGURE 84



   b. Bring tool into contact with wheel and grind until length of back rake is about width of tool

   (NOTE: Cutoff blades are preground with side relief angles; never grind the side of a cutoff blade.)

D. Repeat steps A-C with fine-grit wheel to produce finished surfaces

E. Hone cutting edges of tool with an oilstone to remove wire edges; hold tool, and work stone across cutting edges

INTRODUCTION TO LATHES
UNIT II

JOB SHEET #6--OPERATE LATHE CONTROLS

(NOTE: The better you know where the lathe controls are located, what they do, and how they work, the easier it will be to learn the skills necessary to perform various engine lathe operations.)

I. Equipment--Engine lathe

II. Procedure

(NOTE: The procedures explained below are those for a Colchester 15-inch engine lathe. If other type of equipment is in your shop, use the operator's manual to perform the tasks listed below.)

A. Check the following controls to make sure that they are in a neutral or disengaged position

  1. Spindle clutch lever

  2. Feed clutch lever

  3. Half-nut lever

B. Make sure carriage lock screw is loose

C. Depress one-shot oiler, or lubricate carriage

D. Check all oil sight gauges for proper levels

(NOTE: If low, notify instructor so proper oil can be added.)

E. Set spindle speed at about 500 rpm

F. Set feed rate of carriage at 0.008" per revolution (ipr)

G. Use hand feed controls

  1. Move carriage right and left

  2. Turn cross-feed handwheel to move cross slide in and out

  3. Turn compound handwheel and move compound slide back and forth

  4. Loosen locking screws on protractor base and set compound 30° to right of cross feed; snug locking screws

JOB SHEET #6

H. Turn main motor on

1. Start spindle

2. Set feed change controls so that carriage will move to right; then engage feed clutch lever and allow carriage to move 6" to 7" to right

3. Change feed direction with feed reverse controls; engage feed clutch lever and allow carriage to move left 5" to 6"

4. Set feed change shaft so cross slide will move; engage feed clutch lever and move cross slide in and out by means of power

I. Slide tailstock about 2 inches to right and tighten lock; turn tailstock handwheel until reading shows that spindle is out of housing 3 inches; tighten spindle lock

(NOTE: Never stop machine without putting all clutches and feed levers in disengaged positions.)

J. Stop spindle rotation with spindle clutch lever; shut off main power switch

K. Have instructor demonstrate use of half-nut lever and thread-chasing dial and how to set lathe to cut different pitch threads

L. Set lathe to cut 8 threads per inch; set rpm at 60 and practice engaging half-nut lever on unnumbered lines of thread-chasing dial

(NOTE: Half-nut lever is engaged on either numbered or unnumbered lines when cutting even numbers of threads.)

M. Set lathe to cut 13 threads per inch; set rpm at 60 and practice engaging half-nut lever on numbered lines of thread-chasing dial

(NOTE: Odd numbers of threads are cut on numbered lines.)

N. Practice setting rpm and feed rate at different settings and move carriage by means of power

(CAUTION: Do not use high rpm with fast feed rates. If you cannot remember how to stop the movement of the carriage, stop the machine by shutting off power or by stepping on emergency stop bar.)

INTRODUCTION TO LATHES
UNIT II

TEST

NAME______________________________ SCORE ______________

1. Match terms associated with lathes to their correct definitions. Write the correct numbers in the blanks.

_____a. Rate at which cutting edge moves along surface of work; expressed in surface feet per minute (sfpm)

_____b. Edge that cuts as tool is advanced into work

_____c. General term for bench and floor-model lathes with headstock, bed, carriage, and tailstock

_____d. Groove ground near cutting edge that causes chip to break instead of flowing as a continuous ribbon

_____e. Complete list of all parts, hardware, and materials needed to complete a job

_____f. Angle of cutting edge in relation to tool shank

_____g. Lathe with headstock design that uses gear settings to produce a wide range of spindle speeds

_____h. Period of time during which a cutting tool maintains its ability to cut efficiently between reconditioning

_____i. Cutting tool with single cutting edge used to remove material from work

_____j. Cutting tools not designed to be sharpened

_____k. Lathe with precisely controlled rate of movement between revolutions of spindle and feed of carriage

_____l. Ability to resist wear caused by excessive heat generated at cutting edge by friction produced by chips moving over cutting tool

_____m. Tool that cuts the inverse of its form on work

1. Engine lathe
2. Single-point cutting tool
3. Cutting speed
4. Screw-cutting lathe
5. Tool life
6. Chip breaker
7. Crater resistance
8. Cutting edge
9. Bill of materials
10. Disposable inserts
11. Cutting-edge angle
12. Geared-head lathe
13. Forming tool

TEST

2. Match types of lathes to their correct uses. Write the correct numbers in the blanks.

_____a. Used to produce large numbers of parts; may be operated manually or semiautomatically

_____b. Small, floor-mounted lathe made for accuracy

_____c. Production machine controlled by tape or computer; performs many jobs previously done on turret and bar machines

_____d. Used to produce small parts; usually a precision machine mounted on a bench or table

_____e. Used for light production; most common of all engine lathes; several sizes available for various sizes of work

_____f. Designed primarily for oil field industry; large hole through spindle holds long lengths of large-diameter work

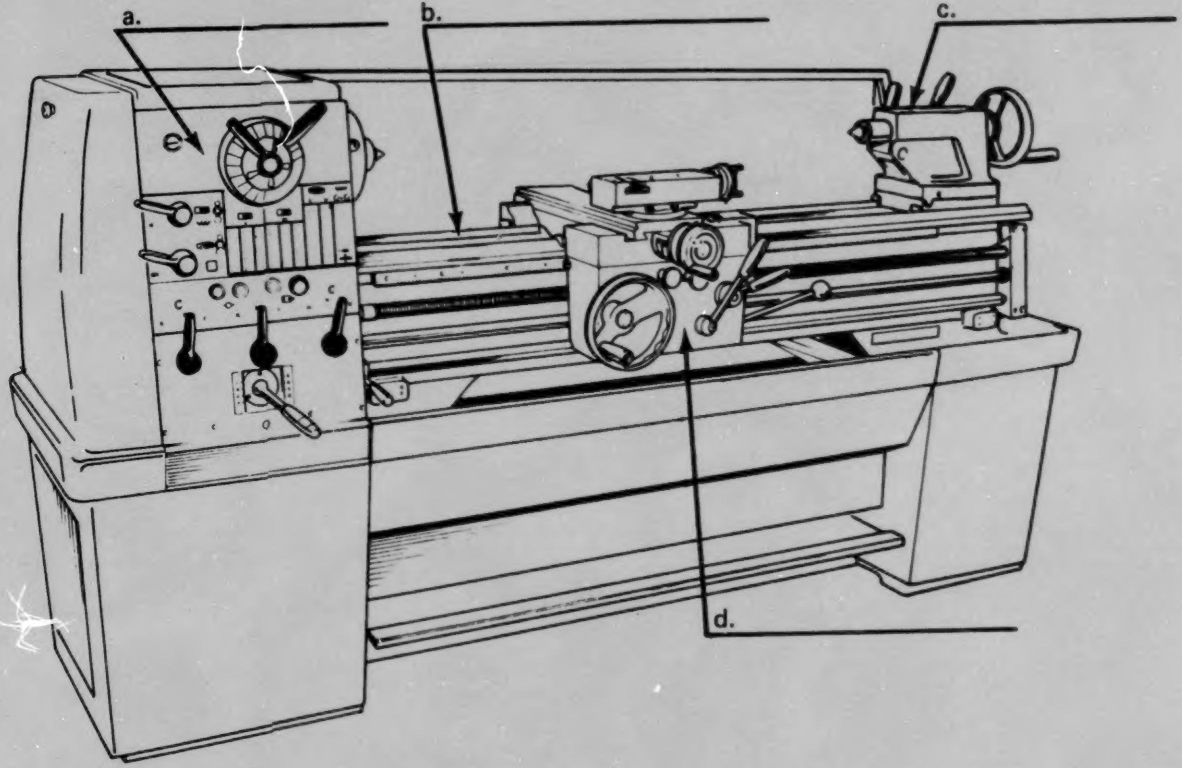
_____g. Small production lathe; also called a *second operation lathe*

1. Numerical-control lathe
2. Toolroom lathe
3. Hollow-spindle lathe
4. Production lathe (turret lathe)
5. Floor-mounted lathe
6. Bench lathe
7. Speed lathe

TEST

3. Identify the major parts of the engine lathe below. Write the correct names in the blanks.

Headstock	**Tailstock**
Carriage	**Bed**

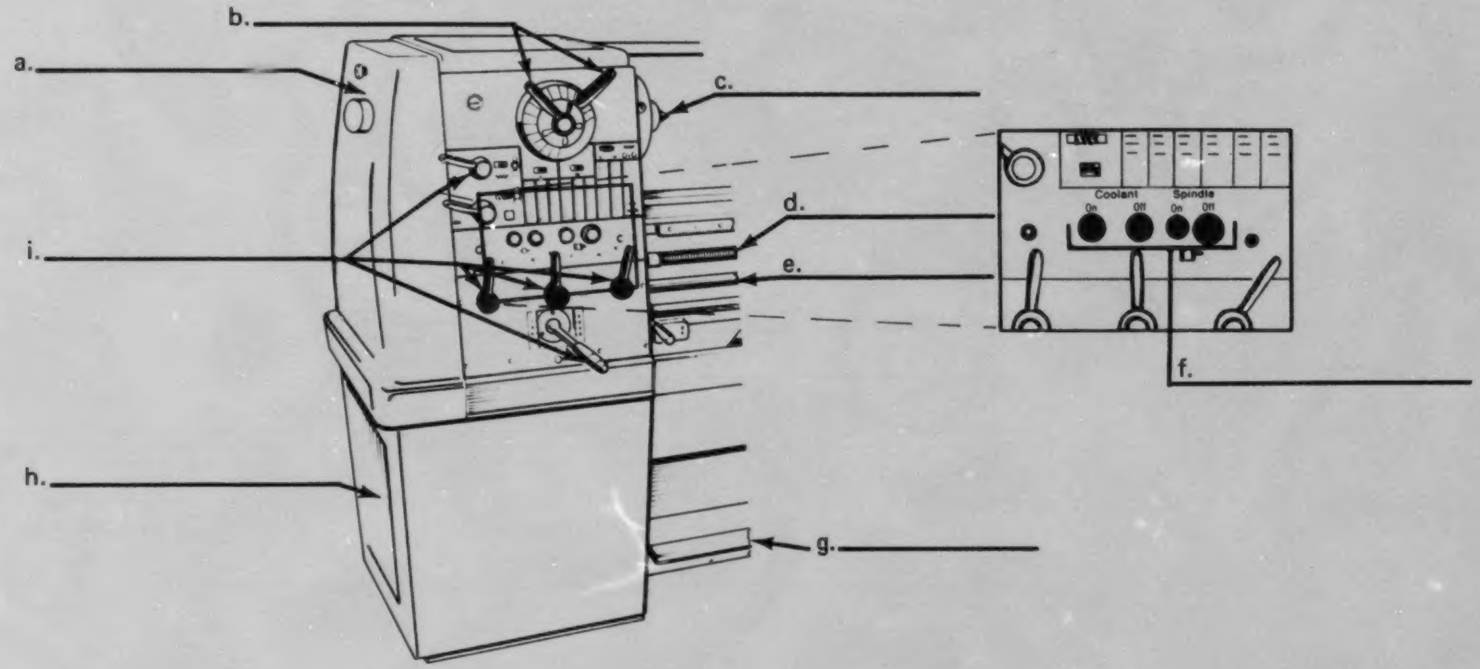


TEST

4. Identify the major parts of the lathe headstock. Write the correct names in the blanks.

Feed rod
Switches
Feed-change levers
Spindle nose
Motor cover

Foot brake
Lead screw
Speed-change levers
Drive belt cover


b.
a.
c.
d.
e.
i.
f.
h.
g.
Coolant
Spindle
On
Off
On
Off

TEST

5. Match headstock parts to their correct uses. Write the correct numbers in the blanks.

_____a. Disengages clutch and applies brake to stop machine

_____b. Determine amount of feed per revolution of spindle

_____c. Receives movement from headstock, and transmits power to carriage

_____d. Regulate revolutions per minute that spindle turns

_____e. Control power to main motor and coolant pump

_____f. Receives movement from headstock, and transmits power to carriage for movement of longitudinal and cross feeds

_____g. Protective guard for motor, pump, and pulleys

_____h. Part of spindle on which work-holding devices are mounted

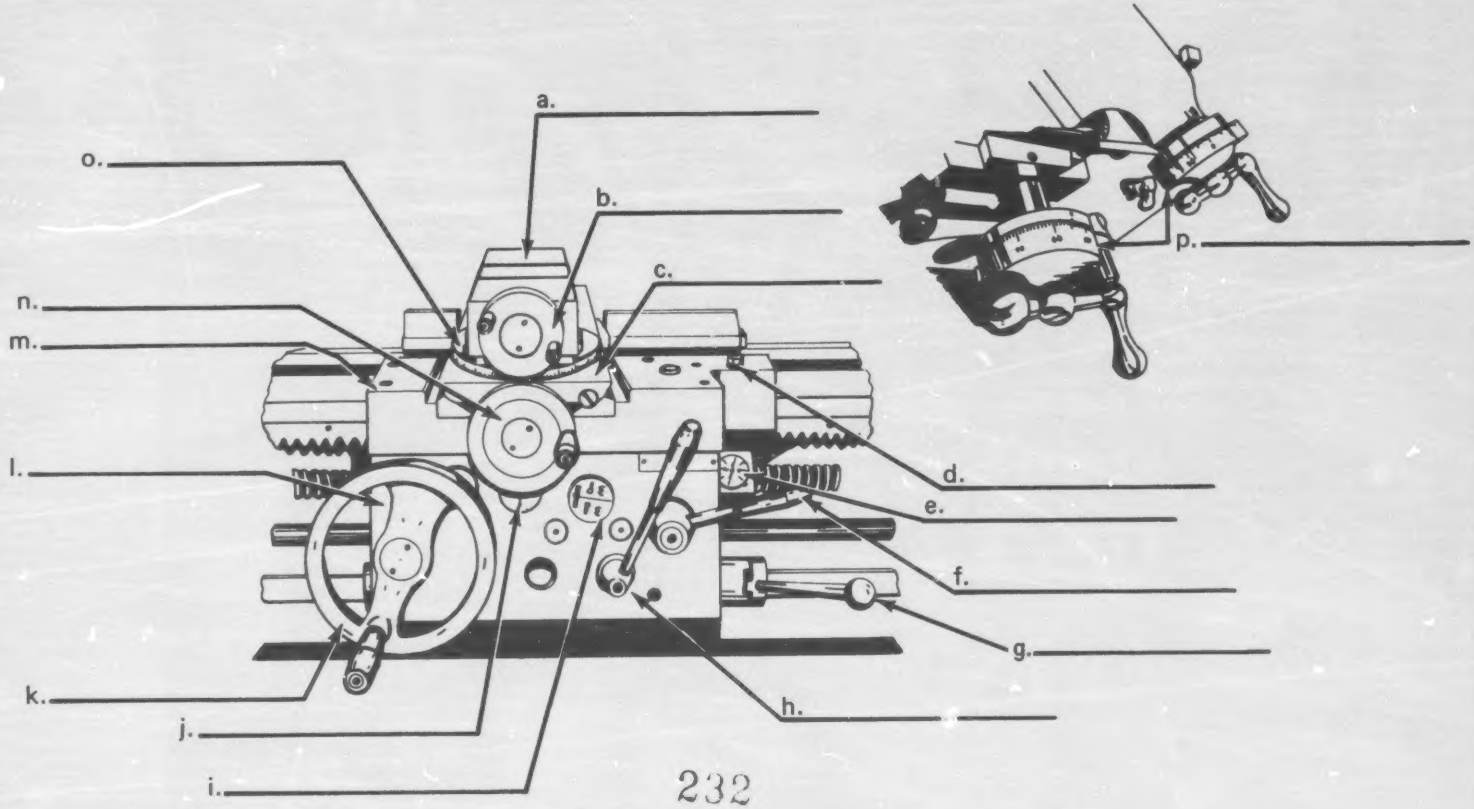
_____i. Protective guard for drive belts

1. Drive belt cover
2. Lead screw
3. Feed-change levers
4. Spindle nose
5. Feed rod
6. Switches
7. Speed-change levers
8. Foot brake
9. Motor cover

TEST

6. Identify parts of the lathe carriage below. Write the correct names in the blanks.

- **Feed-reverse knob**
- **Carriage-lock screw**
- **Graduated micrometer collars**
- **Thread-chasing dial**
- **Spindle clutch lever**
- **Feed-change knob**
- **Saddle**
- **Protractor base**
- **Carriage handwheel**
- **Compound rest**
- **Cross-slide feed handle**
- **Feed clutch lever**
- **Cross slide**
- **Compound-rest feed handle**
- **Half-nut lever**
- **Apron**



TEST

7. Match carriage parts to their correct uses. Write the correct numbers in the blanks. Uses are continued on the next page.

______a. Carries toolholder; is moved with manual feed only

______b. Revolves with lead screw to indicate to operator when to engage half-nut lever; synchronizes movement of carriage to that of lead screw

______c. Moves cross slide in or out with micrometer accuracy

______d. Mechanical clamp used when performing heavy facing or cutoff operations; keeps carriage from moving longitudinally

______e. Allows compound rest movement along any angle

______f. Carries compound rest in or out by either power or manual feed

______g. Contains carriage, cross-slide controls, and oil reservoir to lubricate saddle and other gears contained in the housing

______h. Allow compound and cross slide to have measured movement

______i. Selects longitudinal feed or cross feed for power carriage movement

______j. Engages and disengages driving mechanism of headstock to produce spindle rotation

______k. H-shaped casting which slides along the ways and carries cross slide and apron as it moves between headstock and tailstock

______l. Selects direction of power movements of carriage or cross slide

______m. Moves carriage longitudinally; connected to a gear that meshes with rack mounted parallel to bed

1. Thread-chasing dial
2. Compound-rest feed handle
3. Saddle
4. Feed-reverse knob
5. Compound rest
6. Apron
7. Feed-change knob
8. Carriage-lock screw
9. Protractor base
10. Carriage handwheel
11. Feed clutch lever
12. Spindle clutch lever
13. Cross-slide feed handle
14. Half-nut lever
15. Graduated micrometer collars
16. Cross slide

TEST

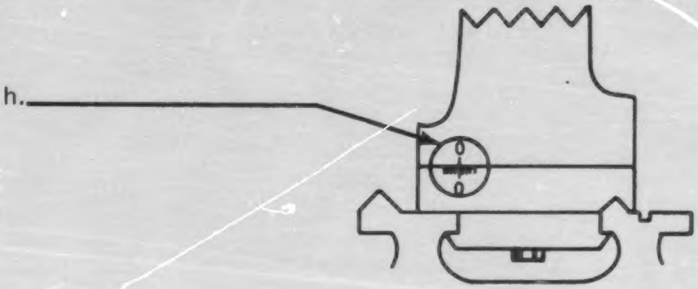
_____n. Engages and disengages half-nut to lead screw in order to cut threads

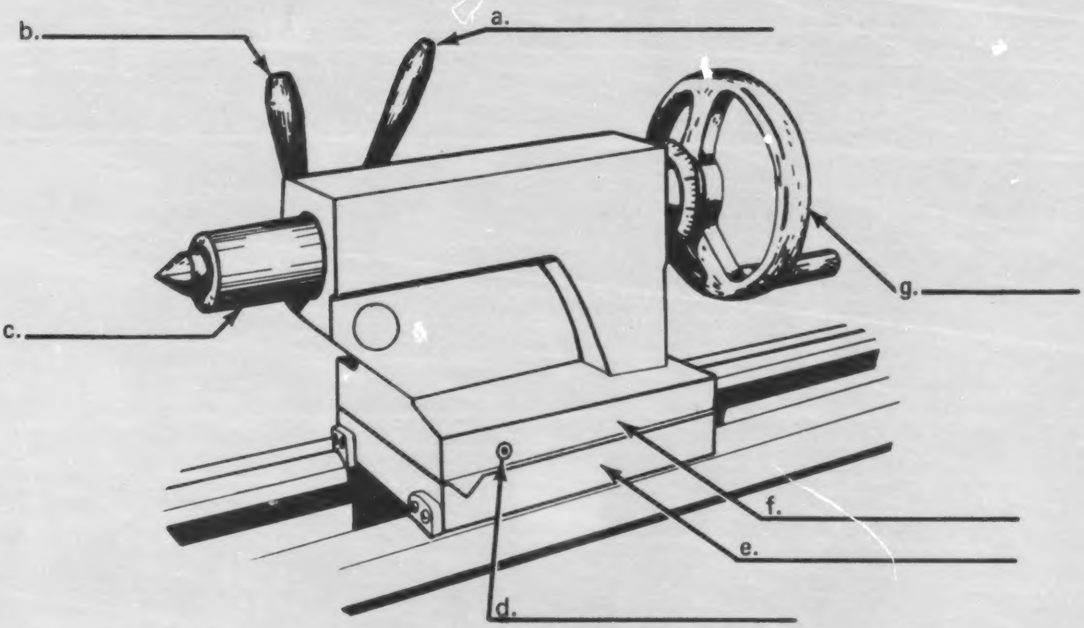
_____o. Engages and disengages carriage power feeds

_____p. Feeds compound rest back and forth in a straight line at angle to which protractor base of compound is set

8. Identify parts of the lathe tailstock below. Write the correct names in the blanks.

Handwheel
Tailstock offset screws
Spindle-lock handle
Tailstock upper casting
Witness mark
Spindle
Clamp-bolt handle
Tailstock lower casting





TEST

9. Match tailstock parts to their correct uses. Write the correct numbers in the blanks.

_____a. Locks spindle in place

_____b. Engages clamping mechanism that locks tailstock assembly to bed

_____c. Moves spindle in or out of its housing

_____d. Indicates tailstock alignment

_____e. Houses spindle and other parts of tailstock

_____f. Supports upper casting and moves assembly along bed; provides accurate alignment

_____g. Align or set tailstock offset

_____h. Holds centers, drills, reamers, and chucks with Morse tapers; moved with handwheel; graduated for reference

1. Tailstock offset screws
2. Handwheel
3. Spindle
4. Tailstock lower casting
5. Clamp-bolt handle
6. Spindle-lock handle
7. Tailstock upper casting
8. Witness mark

10. Match lathe accessories to the correct applications. Write the correct numbers in the blanks. Accessories and applications are continued on the next two pages.

_____a. Used to support long work that is usually held at both ends; mounted to the carriage, it prevents work from pushing away from tool

_____b. Used to hold tool or toolholder; must be adjusted each time a different tool or toolholder is used

_____c. Used to hold round or irregularly shaped parts; each jaw moves independently

_____d. Used in tailstock spindle; revolves with work, eliminating friction between work center and lathe center; allows use of higher spindle speeds

_____e. Used to mount work or fixtures by means of bolts and clamps when part cannot be held in chuck or between centers; often used in production setup

_____f. Used on chucks with two-piece jaws; mounted in place of hard jaws so that jaws can be machined to conform to a particuiar radius; make holding pressure more uniform without cutting into work

1. Follower rest
2. Face plate
3. Tool post
4. Ball-bearing center
5. Soft jaws
6. Four-jaw independent chuck

TEST

______g. Used to cut tapers and other contours from a pattern

______h. Used to mount toolholders; allows different tools to be used without adjustment each time

______i. Used to transmit power from spindle to work by means of lathe dog; mounted directly to spindle

______j. Used to hold round parts where concentricity is not critical; jaws can be changed or reversed for inside or outside holding; all jaws move in unison

______k. Used to hold work from the inside of a round hole by means of a slight taper, and is then mounted between centers; outside diameter can be machined true to inside diameter

______l. Special tool used to produce a diamond or straight pattern on work; is held in toolholder and moves with carriage

______m. Used to support inside diameter of large pipe when turning; is mounted in tailstock and revolves with work

______n. Used to cut internal or external tapers and tapered threads without moving alignment of tailstock; graduated in degrees and inches per foot and mounted to carriage; moves carriage cross feed along desired taper when clamped to bed

______o. Allows four tools to be preset; tools can be rotated by loosening lock; excellent for short production runs

______p. Used to adapt tapered-shank tools to taper of tailstock

______q. Clamps to round work and transmits power from drive plate to work

______r. Used in headstock and tailstock when turning between centers; used in tailstock to support long work that must be machined

______s. Used to accurately control movement of carriage along length of bed

7. Tracer attachment
8. Drive plate (dog plate)
9. Bent-tail lathe dog
10. Compound-turret toolholder
11. Lathe centers
12. Mandrel
13. Three-jaw universal chuck
14. Micrometer carriage stop
15. Quick-change tool post
16. Pipe center
17. Taper attachment
18. Sleeve adapter
19. Knurling tool

TEST

______ t. Used for light-duty work on stock that is usually one inch or smaller; available for square, round, or hexagonal stock

______ u. Adapts lathe-spindle taper to Morse taper, which holds center when work is to be turned between centers; also holds drilling and reaming tools when work is mounted to carriage

______ v. Used to support long work; bolted to lathe bed

______ w. Used when cutting threads; allows speeds two to three times faster than are normally possible

______ x. Used to hold drills or reamers; may be mounted in headstock or tailstock of lathe

______ y. Used to grind inside or outside diameters; mounted on carriage which controls its movements

______ z. Used to transmit power from drive plate to work; holds square, rectangular, or round work

______ aa. Used as positive stop to feed cross feed into; eliminates need to remember how many revolutions away from work cross feed was turned

______ bb. Used to keep coolant from being thrown from revolving chuck or work; helps stop chips from flying as they break off

20. Clamping lathe dog
21. High-speed threading attachment
22. Tool-post grinder
23. Steady rest
24. Drill chuck
25. Splash and chip guard
26. Spindle adapter
27. Collet chuck
28. Adjustable thread-cutting stop

11. Name three types of spindle drives.

a. ______________________________

b. ______________________________

c. ______________________________

TEST

12. State rules for care and cleaning of the engine lathe.
    a. Electrical power--
    b. Compressed air--
    c. Cleaning--
    d. Oil levels--
    e. Lubrication--
    f. Gibs--
    g. Shear pins--
    h. Clutches--

13. State rules for safe use of the engine lathe.
    a. Eye protection--
    b. Sharp edges--
    c. Clothing--

TEST

d. Rags-- ______

e. Chuck wrench-- ______

f. Hands-- ______

g. Large or oddly shaped parts that are chucked-- ______

h. Work-holding devices-- ______

i. Guards-- ______

j. Measuring, adjusting, cleaning, or oiling-- ______

k. Floor-- ______

l. Watches and rings-- ______

m. Horseplay-- ______

n. Tools-- ______

o. Chucks-- ______

TEST

14. Match basic lathe operations to their correct descriptions. Write the correct numbers in the blanks.

______a. Forming internal or external threads with a single-point tool

______b. Producing a hole with a drill

______c. Producing internal threads with a tap, using lathe tailstock to guide tap

______d. Finishing surface where two diameters or steps meet

______e. Producing a desired shape by using a tool ground to that shape

______f. Enlarging a hole slightly with a multi-fluted cutter

______g. Cutting a recess in work

______h. Enlarging an existing hole

______i. Producing a tapered hole in end of work so that part can be held between centers or be used as a starting hole for drilling operation

______j. Cutting a part from work with a thin tool while work is rotating

______k. Removing material from end surface of part

______l. Chamfering or reducing diameter of work with a file while work is rotating

______m. Producing a raised pattern on surface of work to improve grip or appearance or to increase diameter

______n. Producing a flat, angular surface on the edge of a machined part

______o. Removing material from outside surface of part

______p. Producing uniform change in diameter of part as measured along its axis

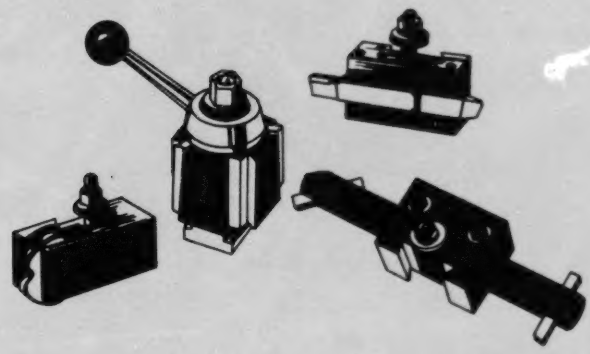
______q. Improving surface finish of part with abrasive cloth while work is turning

1. Threading
2. Drilling
3. Forming
4. Shouldering
5. Reaming
6. Tapping
7. Grooving
8. Boring
9. Center drilling
10. Facing
11. Cutoff
12. Filing
13. Turning
14. Knurling
15. Chamfering
16. Polishing
17. Tapering

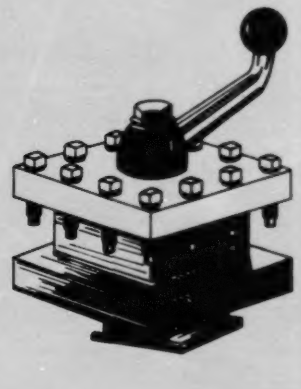
TEST

15. Identify types of tool posts and toolholders. Write the correct names in the blanks.

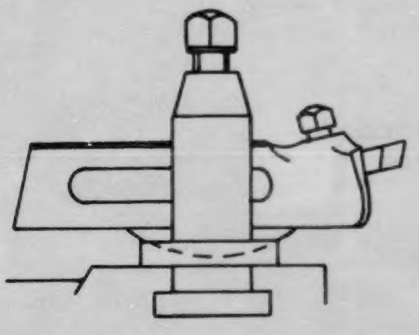
Round tool post and toolholder
Compound-turret tool post (square turret)
Quick-change tool post and holders
Heavy-duty, open-face tool post and holder
Boring bar and holder



a. ______________________________



b. ______________________________



c. ______________________________

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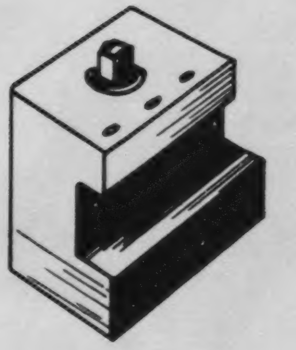
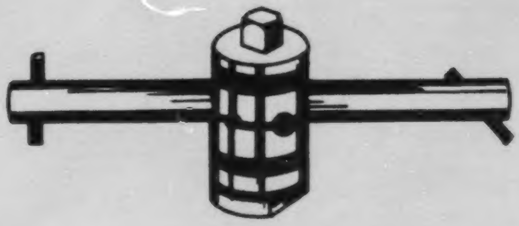


d. ____



e. ____

16. List uses of the following types of tool posts and toolholders.

a. Boring bar holder-- ________________________________

____

____

Heavy-duty, open-face tool post-- ______________________

____

____

c. Round tool post and holders-- _________________________

____

____

TEST

d. Quick-change toolholder--

e. Turret tool post and holder--

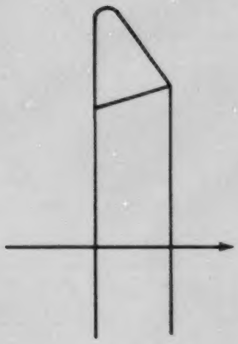
17. Define tool bit geometry.

TEST

18. Identify basic shapes of single-point cutting tools. Write the correct names in the blanks.

    a. High-speed steel

Square-nose chamfer or turning
Left-hand turning
Round-nose turning
Internal threading
Right-hand facing
Threading
Parting or grooving
Right-hand turning
Left-hand facing
Boring



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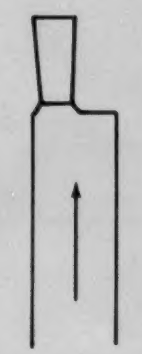

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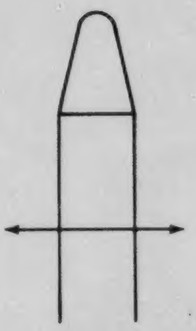

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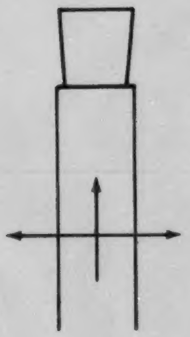

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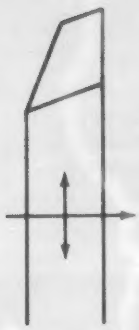
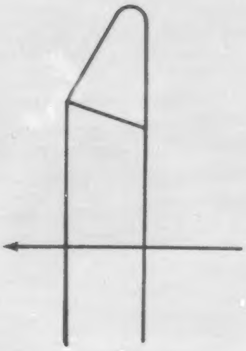
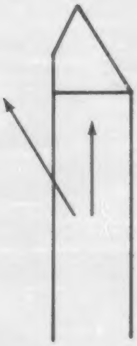
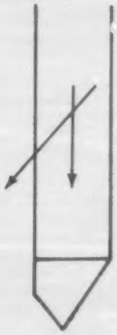


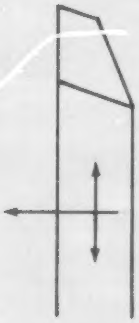


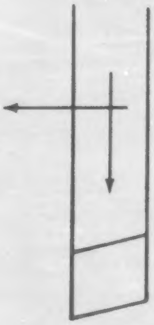
5) ______________________ 6) ______________________





7) ______________________ 8) ______________________





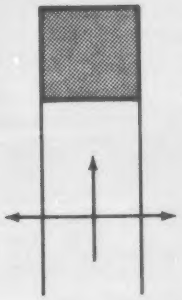
9) ______________________ 10) ______________________

TEST

b. Brazed carbide

Right-hand threading
Right-hand finish turning
Left-hand finish turning
Right-hand rough turning
V-grooving or turning
Left-hand facing or shouldering

Right-hand rough turning or facing
Parting or recessing
Left-hand rough turning
Square-nose chamfer or turning
Round-nose grooving or turning
Right-hand facing or shouldering



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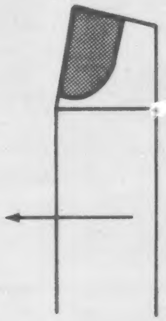

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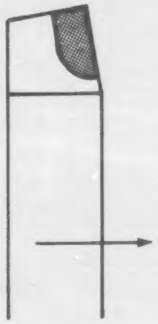

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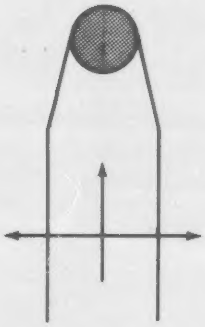

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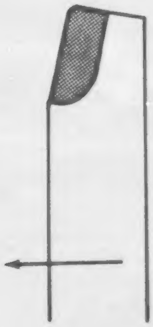

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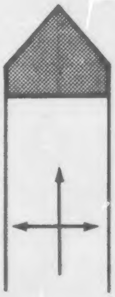

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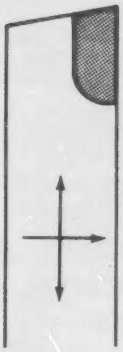

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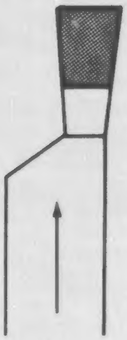

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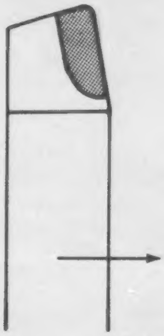

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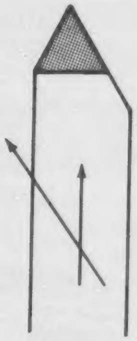

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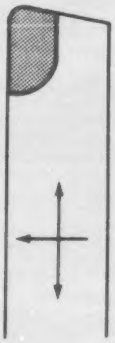

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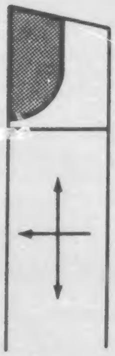
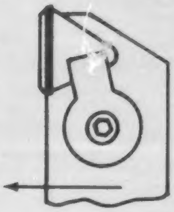


12) ____________________

TEST

c. Carbide inserts

Boring
Right-hand grooving
Right-hand tapering or contouring
Right-hand turning
Right-hand threading
Right-hand facing



1) ______________
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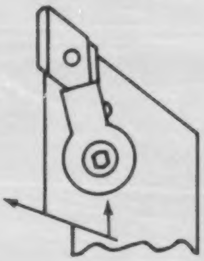
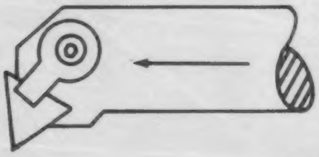
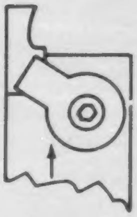


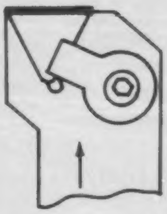
2) ______________
____



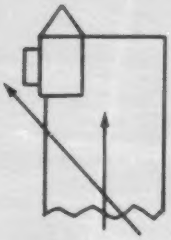
3) ______________
____



4) ______________
____



5) ______________
____



6) ______________
____

19. Match types of carbide to their correct applications. Write the correct numbers in the blanks. Applications are continued on the next page.

_____a. Used for medium to very heavy roughing on a broad variety of plain carbon steels, alloy steels, tool steels, free-machining steels, 400- and 500-series stainless steels, and alloy cast irons; very good general-purpose, uncoated grade that is good for turning and milling

_____b. Used for very high-speed finishing on all types of materials; basically used for light chip loads on very rigid setups

_____c. Used for finishing to high-speed finishing on a broad variety of cast irons and steels

1. Cemented oxide (uncoated)
2. Straight tungsten carbide (TiC coated)
3. Straight tungsten carbide (uncoated)
4. Complex tungsten carbide (TiC coated)
5. Complex tungsten carbide (uncoated)
6. Complex tungsten carbide (Al_2O_3 coated)

TEST

_____d. Used for medium roughing to finishing on nodular, malleable, gray, or chilled cast iron; 200- and 300-series stainless steels; a broad variety of high-temperature, high-strength alloys; and refractory alloys and nonmetals

_____e. Used for medium roughing to finishing on a broad variety of plain carbon steels, alloy steels, free-machining steels, tool steels, and 400- and 500-series stainless steels; very good general-purpose, coated grade

_____f. Used for light roughing to finishing on a broad variety of cast irons and steels

20. Compare advantages and disadvantages of carbide and high-speed steel cutting tools. Write a "C" in the blanks before carbide, and an "H" before high-speed steel.

a. Advantages

_____1) Allows use of higher cutting speeds and feeds

_____2) Can be ground easily to different shapes

_____3) Allows greater production output

_____4) Has longer tool life

_____5) Will machine harder materials

_____6) Excellent for some nonferrous and nonmetal materials that require extreme clearance and relief angles

_____7) Inserts are preground

b. Disadvantages

_____1) Older machines are not rigid and lack required speeds

_____2) Must be ground to shape

_____3) Will not withstand high temperatures

_____4) Easily broken or chipped

_____5) Will not cut some very hard materials

_____6) Must be sharpened often

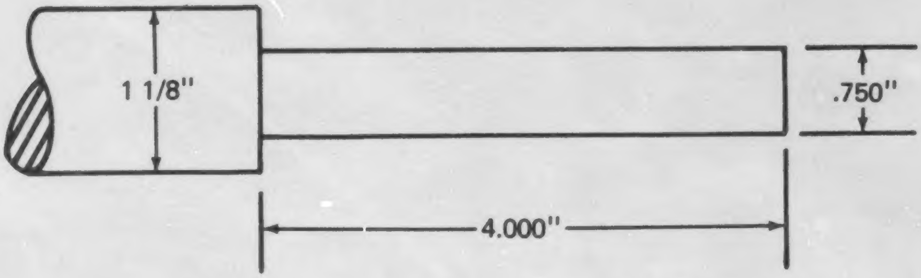
_____7) Induces internal stress in work with high carbon content

TEST

21. Use shop formulas and charts to determine lathe speeds, feeds, and depth of cut. Refer to the charts that follow the Information Sheet.

    (NOTE: Round all rpm to whole numbers; write all feeds as three-place decimals. Use 1 1/8" diameter to calculate roughing rpm and a 3/4" diameter to calculate finish rpm. Show your work.)

    a. Using high-speed steel to machine 1 1/8" diameter low carbon steel (SAE 1020) round bar 7" long, cut 4" of the bar to 3/4" diameter.



1) Roughing rpm = ____________________

2) Finishing rpm = ____________________

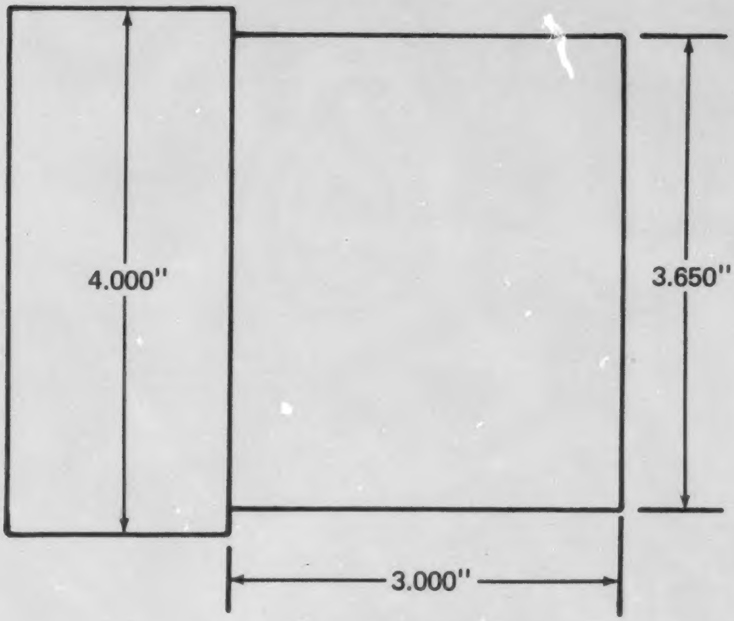
3) Roughing feed = ____________________

4) Finishing feed = ____________________

5) If you allow one cut for finishing, how many rough cuts will you make before making the finish cut?____________________

TEST

b. Using throw-away carbide, cut a 4" aluminum bar that is solution-treated and aged from 4" to 3.650" diameter; make a cut 3" long.



1) Roughing rpm = ______________________

2) Finishing rpm = ______________________

3) Roughing feed = ______________________

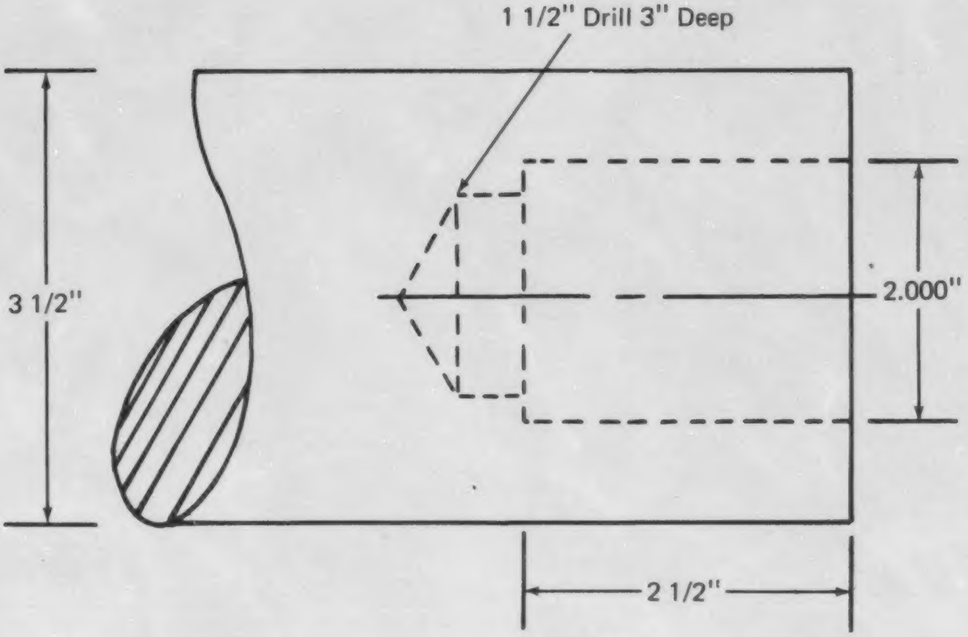
4) Finishing feed = ______________________

5) If you allow one cut for finishing, how many rough cuts will be required before you make a finish cut? ____________________

TEST

c. Using a carbide boring tool (throw-away), bore a 2" hole after it has been drilled to 1 1/2" diameter; material is soft cast iron.

(NOTE: Roughing diameter is 1 1/2", finish diameter 2.000"; round rpm to whole number.)



1) Roughing rpm = ____________________

2) Finishing rpm = ____________________

3) Roughing feed = ____________________

4) Finishing feed = ____________________

5) If you allow one cut for finishing, how many rough cuts will you make? ____________________

TEST

22. List factors to consider when calculating machining time.

    a. ______________________________

    b. ______________________________

    c. ______________________________

    d. ______________________________

(NOTE: Test questions 23-25 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

23. Calculate time required to turn or bore workpieces.

24. Complete safety test for engine lathe operations.

25. Demonstrate the ability to

    a. Free-hand grind a turning tool.

    b. Free-hand grind a facing tool.

    c. Free-hand grind a 60° threading tool.

    d. Free-hand grind a square-nose tool.

    e. Sharpen a cutoff tool blade.

    f. Operate lathe controls.

INTRODUCTION TO LATHES
UNIT II

ANSWERS TO TEST

1. a. 3
   b. 8
   c. 1
   d. 6
   e. 9
   f. 11
   g. 12
   h. 5
   i. 2
   j. 10
   k. 4
   l. 7
   m. 13

2. a. 4
   b. 2
   c. 1
   d. 6
   e. 5
   f. 3
   g. 7

3. a. Headstock
   b. Bed
   c. Tailstock
   d. Carriage

4. a. Drive belt cover
   b. Speed-change levers
   c. Spindle nose
   d. Lead screw
   e. Feed rod
   f. Switches
   g. Foot brake
   h. Motor cover
   i. Feed-change levers

ANSWERS TO TEST

5.	a.	8	f.	5
	b.	3	g.	9
	c.	2	h.	4
	d.	7	i.	1
	e.	6		

6.	a.	Compound rest	i.	Feed-reverse knob
	b.	Compound-rest feed handle	j.	Feed-change knob
	c.	Cross slide	k.	Carriage handwheel
	d.	Carriage-lock screw	l.	Apron
	e.	Thread-chasing dial	m.	Saddle
	f.	Half-nut lever	n.	Cross-slide feed handle
	g.	Spindle clutch lever	o.	Protractor base
	h.	Feed clutch lever	p.	Graduated micrometer collars

7.	a.	5	e.	9	i.	7	m.	10
	b.	1	f.	16	j.	12	n.	14
	c.	13	g.	6	k.	3	o.	11
	d.	8	h.	15	l.	4	p.	2

8.	a.	Clamp-bolt handle
	b.	Spindle-lock handle
	c.	Spindle
	d.	Tailstock offset screws
	e.	Tailstock lower casting
	f.	Tailstock upper casting
	g.	Handwheel
	h.	Witness mark

ANSWERS TO TEST

9. a. 6
   b. 5
   c. 2
   d. 8
   e. 7
   f. 4
   g. 1
   h. 3

10. a. 1
    b. 3
    c. 6
    d. 4
    e. 2
    f. 5
    g. 7
    h. 15
    i. 8
    j. 13
    k. 12
    l. 19
    m. 16
    n. 17
    o. 10
    p. 18
    q. 9
    r. 11
    s. 14
    t. 27
    u. 26
    v. 23
    w. 21
    x. 24
    y. 22
    z. 20
    aa. 28
    bb. 25

11. Answer should include any three of the following

    a. Flat belt

    b. Manual shift V-belt

    c. Variable pulley

    d. Geared-head

12. a. Shut off before thoroughly cleaning machine

    b. Use with extreme caution; do not force chips or dirt underneath felt wipers or between bearing surfaces; flying chips may cause injury

    c. Use a brush to remove chips; wipe with clean cloth to remove dirt and sludge, and then wipe a thin coat of protective oil on all finished steel surfaces to prevent rust

    d. Check daily

    e. Check chart in owner's manual to determine how often to lubricate and the type of lubricant to use

ANSWERS TO TEST

f. Never adjust before checking with instructor

g. Check with instructor before replacing

h. Report to instructor if machine pulls down or is slow to reach speed, as these actions will damage the clutch

13. a. Wear approved safety glasses with side shields

b. Remove all sharp edges and burrs from work

c. Wear close-fitting clothes with shirttail tucked into pants; roll up long sleeves past elbow, or button

d. Never use around revolving or moving parts

e. Remove immediately; never leave in chuck

f. Never use hands to try to stop lathe spindle or chuck, to grab chips, or to remove hot work from work-holding device

g. Rotate work a complete revolution by hand to make sure jaws and work clear the ways and carriage

h. Always check to make sure that they are mounted securely

i. Never operate a machine with guards removed

j. Stop lathe

k. Keep clean and free of chips and oil to eliminate slipping and tripping hazards

l. Remove before operating machinery

m. Is strictly prohibited in shop area

n. Never leave lying on machine

o. Always clean before mounting on spindle; never set directly on the ways (use a wooden chuck cradle)

14. a. 1

b. 2

c. 6

d. 4

e. 3

f. 5

g. 7

h. 8

i. 9

j. 11

k. 10

l. 12

m. 14

n. 15

o. 13

p. 17

q. 16

ANSWERS TO TEST

15. a. Quick-change tool post

    b. Compound-turret tool post (square turret)

    c. Round tool post and toolholder

    d. Heavy-duty, open-face tool post and holder

    e. Boring bar and holder

16. a. Holds boring bar for internal turning or boring

    b. Holds high-speed or carbide cutting tools for heavy machining

    c. Used to get into tight places when work is supported with tailstock

    d. Allows tools to be preadjusted and changed without readjusting; can be used for short-run production; holds high-speed or carbide cutting tools for medium machining

    e. Holds high-speed or carbide tools for heavy machining; holds four tools; indexes and repeats itself for production machining

17. Shape produced by grinding of proper angles on a cutting tool, allowing maximum chip removal and tool life, and producing the desired finish

18. a.
    1) Left-hand turning
    2) Parting or grooving
    3) Round-nose turning
    4) Square-nose chamfer or turning
    5) Left-hand facing
    6) Right-hand turning
    7) Threading
    8) Internal threading
    9) Right-hand facing
    10) Boring

    b.
    1) Square-nose chamfer or turning
    2) Right-hand finish turning
    3) Left-hand finish turning
    4) Round-nose grooving or turning
    5) Right-hand rough turning
    6) V-grooving or turning
    7) Left-hand facing or shouldering
    8) Parting or recessing
    9) Left-hand rough turning
    10) Right-hand threading
    11) Right-hand rough turning or facing
    12) Right-hand facing or shouldering

ANSWERS TO TEST

c. 1) Right-hand turning
   2) Right-hand tapering or contouring
   3) Boring
   4) Right-hand grooving
   5) Right-hand facing
   6) Right-hand threading

19. a. 5
    b. 1
    c. 6
    d. 3
    e. 4
    f. 2

20. a. 1) C
       2) H
       3) C
       4) C
       5) C
       6) H
       7) C
    b. 1) C
       2) H
       3) H
       4) C
       5) H
       6) H
       7) C

21. a. 1) 427 rpm
       2) 853 rpm
       3) 0.015 ipr
       4) 0.007 ipr
       5) 2 rough cuts
    b. 1) 1500 rpm
       2) 1973 rpm
       3) 0.020 ipr
       4) 0.010 ipr
       5) 2 rough cuts
    c. 1) 1107 rpm
       2) 920 rpm
       3) 0.010 or 0.015 ipr
       4) 0.008 ipr
       5) 3 to 5 depending on depth of rough cuts

22. a. Speed (rpm)
    b. Feed rate (ipr)
    c. Length of cut
    d. Number of cuts (amount of material to be removed)

ANSWERS TO TEST

23. Evaluated to the satisfaction of the instructor
24. Evaluated to the satisfaction of the instructor
25. Performance skills evaluated to the satisfaction of the instructor

ENGINE LATHE OPERATIONS
UNIT III

UNIT OBJECTIVE

After completing this unit, the student should be able to use the engine lathe to perform various operations. The student should also be able to perform shop math required to calculate tapers and find angles or sides of right triangles. This knowledge will be shown by completing assignment sheets, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with engine lathe operations to their correct definitions.
2. Match taper formulas to their correct applications.
3. Label sides of right triangles.
4. Calculate trigonometric functions of angles.
5. Determine angles, using trigonometric function tables.
6. Determine trigonometric functions of angles.
7. Calculate sides of right triangles.
8. Name the parts of an American National thread form.
9. Identify thread forms.
10. Write formulas used to calculate dimensions for an American National thread form.
11. List methods of measuring thread pitch diameters.
12. Use shop formulas to calculate taper dimensions.
13. Plan production operations.
14. Demonstrate the ability to
    a. Remove and install a lathe chuck.
    b. Perform a facing operation.

OBJECTIVE SHEET

c. Face a part to length.

d. Perform a straight turning operation.

e. Turn a part with square shoulder to length.

f. Use dial indicator to align work in four-jaw chuck.

g. Perform chamfer operations.

h. Perform recessing operations.

i. Perform a center-drilling operation.

j. Perform a knurling operation.

k. Drill and ream a hole.

l. Use lathe center to align and start a tap.

m. Perform cutoff operation.

n. Turn between centers.

o. Turn a taper with taper attachment.

p. Turn a taper with compound.

q. Perform boring operations.

r. Cut external threads to a relief.

s. Pick up threads.

t. Cut internal threads.

ENGINE LATHE OPERATIONS
UNIT III

SUGGESTED ACTIVITIES

I. Suggested activities

   A. Obtain materials planned to supplement unit.

   B. Provide students with objective sheet.

   C. Provide students with information, assignment, and job sheets.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Obtain *Handy Multipliers and Trigonometry Tables for Engineers* by Carr Lane Manufacturing Company, 4200 Carr Lane Court, St. Louis, Missouri 63119, so that students may complete assignment sheets and test.

   H. Check for and secure materials needed for job sheets.

   I. Complete job sheets in sequence because they are designed to complement each other.

   J. After the students have completed all job sheets and Assignment Sheet #5, have them select one of the drawings available to produce the part shown.

   K. Give test.

   L. Reteach and retest if necessary.

II. Instructional materials

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Assignment sheets

      1. Assignment Sheet #1--Use Shop Formulas to Calculate Taper Dimensions

      2. Assignment Sheet #2--Label Sides of Right Triangles

      3. Assignment Sheet #3--Use Trigonometric Function Tables

      4. Assignment Sheet #4--Calculate Sides and Angles of Right Triangles

      5. Assignment Sheet #5--Plan Production Operations

SUGGESTED ACTIVITIES

E. Answers to assignment sheets

F. Job sheets

1. Job Sheet #1--Remove and Install a Lathe Chuck
2. Job Sheet #2--Perform a Facing Operation
3. Job Sheet #3--Face a Part to Length
4. Job Sheet #4--Perform a Straight Turning Operation
5. Job Sheet #5--Turn a Part with Square Shoulder to Length
6. Job Sheet #6--Use Dial Indicator to Align Work in Four-Jaw Chuck
7. Job Sheet #7--Perform Chamfer Operations
8. Job Sheet #8--Perform Recessing Operations
9. Job Sheet #9--Perform a Center-Drilling Operation
10. Job Sheet #10--Perform a Knurling Operation
11. Job Sheet #11--Drill and Ream a Hole
12. Job Sheet #12--Use Lathe Center to Align and Start a Tap
13. Job Sheet #13--Perform Cutoff Operation
14. Job Sheet #14--Turn Between Centers
15. Job Sheet #15--Turn a Taper with Taper Attachment
16. Job Sheet #16--Turn a Taper with Compound
17. Job Sheet #17--Perform Boring Operations
18. Job Sheet #18--Cut External Threads to a Relief
19. Job Sheet #19--Pick up Threads
20. Job Sheet #20--Cut Internal Threads

G. Test

H. Answers to test

III. Unit references

A. Kibbe, Richard, et al. *Machine Tool Practices.* New York: John Wiley and Sons, Inc., 1979.

SUGGESTED ACTIVITIES

B. Krar, S.F., and J.W. Oswald. *Turning Technology.* Albany, New York: Delmar Publishers, 1971.

C. Krar, S.F., J.W. Oswald, and J.E. St. Amand. *Technology of Machine Tools.* Toronto: McGraw-Hill of Canada, Ltd., 1969.

D. Olivo, C. Thomas. *Fundamentals of Machine Technology.* North Scituate, Massachusetts: Breton Publishers/Division of Wadsworth, Inc., 1981.

ENGINE LATHE OPERATIONS
UNIT III

INFORMATION SHEET

I. Terms and definitions

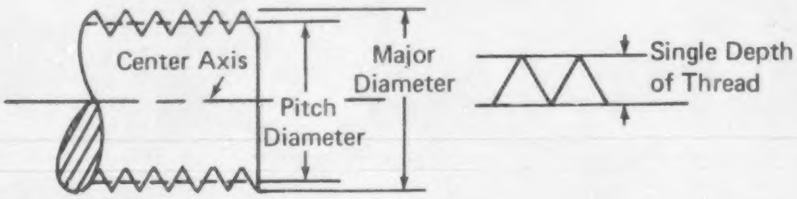
A. Taper--Uniform change in diameter of work along its axis

B. Pitch--Distance from point on one thread to corresponding point on next thread; measured parallel to axis of work

C. Pitch diameter--Imaginary diameter equal to major diameter of threads minus single depth of thread (Figure 1)

EXAMPLE:

FIGURE 1

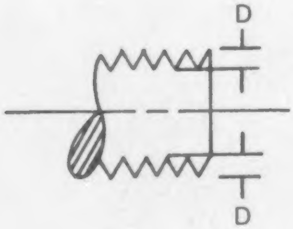


D. Single depth of thread--Distance from top (crest) of one thread to the bottom (root) of thread perpendicular to axis of work

E. Double depth of thread--Two times single depth of thread; sum of depths of threads on each side of screw thread (Figure 2)

EXAMPLE:

FIGURE 2



D = Single Depth
D + D = Double Depth

INFORMATION SHEET

F. Interior angle--Angle that lies inside and between two adjacent lines (Figures 3 and 4)

EXAMPLES:

FIGURE 3

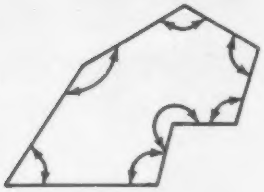
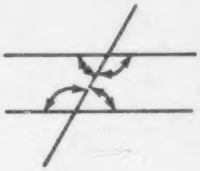


FIGURE 4

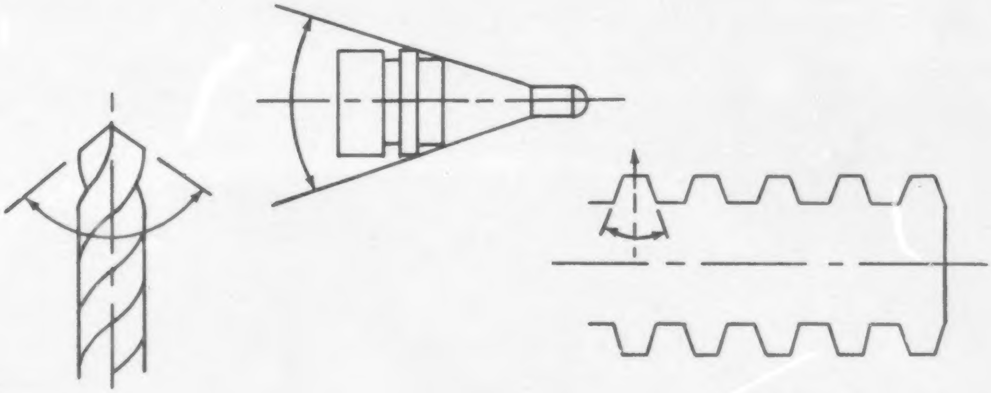


(NOTE: Arrows indicate interior angles.)

G. Included angle--Sum of two equal angles whose common side is center axis of work or a part of work (Figure 5)

EXAMPLE:

FIGURE 5



(NOTE: Arrows indicate included angles.)

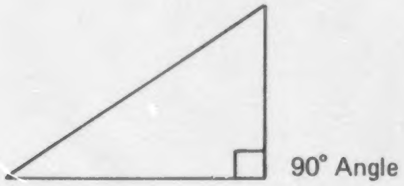
H. Right angle--Angle of 90°

INFORMATION SHEET

I. Right triangle--Triangle with two sides at 90° to each other (Figure 6)

(NOTE: Because the sum of the three angles of any triangle is 180°, the sum of the two remaining angles of a right triangle is also 90°. The 90° or right angle of a right triangle is normally indicated with two short lines that form a square with the sides of the right angle.)

FIGURE 6



J. Side adjacent--Side of right triangle that forms one side of reference angle and one of the sides of right angle

K. Side opposite--Side of a right triangle opposite a designated reference angle; forms one side of right angle

L. Hypotenuse--Side of a right triangle opposite the right angle

M. Sine--Ratio of length of side opposite to the hypotenuse

N. Cosine--Ratio of length of side adjacent to the hypotenuse

O. Tangent--Ratio of length of side opposite to length of side adjacent

P. Reference angle--Any angle used to define a dimension or give a location

Q. Trigonometric function--Ratio of lengths of two sides of a triangle expressed as a decimal

R. Tolerance--Permissible deviation from a design dimension

S. Limits--Maximum and minimum dimensions allowed

INFORMATION SHEET

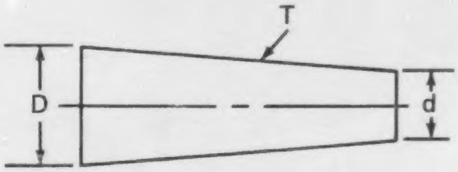
II. Applications of taper formulas (Assignment Sheet #1)

A. $T = D - d$--Used to determine total taper of a part (Figure 7)

(NOTE: To find total taper [T], subtract small diameter [d] from large diameter [D].)

EXAMPLE:

FIGURE 7

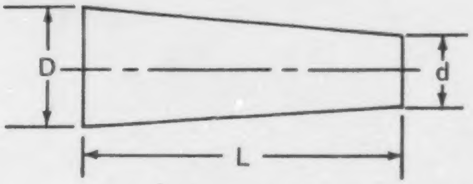


B. $tpi = \frac{D - d}{L}$--Used to determine taper per inch of a part (Figure 8)

(NOTE: To find taper per inch [tpi], subtract the small diameter [d] from the large diameter [D] and divide by the length [L] in inches of the taper parallel to the axis.)

EXAMPLE:

FIGURE 8



C. $tpf = \frac{D - d}{L} \times 12$ or $tpf = tpi \times 12$--Used to determine taper per foot of a part

(NOTE: To find taper per foot [tpf], subtract the small diameter [d] from the large diameter [D], divide by the length [L] of taper in inches, and then multiply by 12; or multiply the tpi by 12. The tpi equals tpf divided by 12.)

D. $D = (tpi \times L) + d$--Used to determine large diameter of a part if taper per inch and small diameter are known

(NOTE: To find large diameter [D], multiply the taper per inch [tpi] by the length [L] of the taper, and add the small diameter [d].)

INFORMATION SHEET

E. $d = D - (tpi \times L)$--Used to determine small diameter of a part if taper per inch and large diameter are known

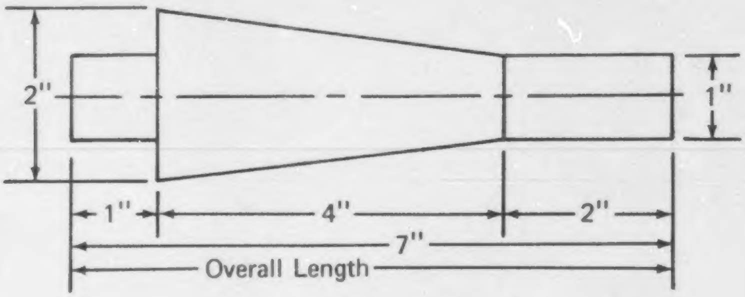
(NOTE: To find the small diameter [d], multiply the taper per inch [tpi] by the length [L] of the taper, and subtract that from the large diameter [D].)

F. $TO = \frac{tpi \times \text{Overall Length}}{2}$ --Used to determine tailstock offset (Figure 9)

(NOTE: To find tailstock offset [TO], multiply the taper per inch [tpi] times the overall length of part and divide by two.)

EXAMPLE:

FIGURE 9

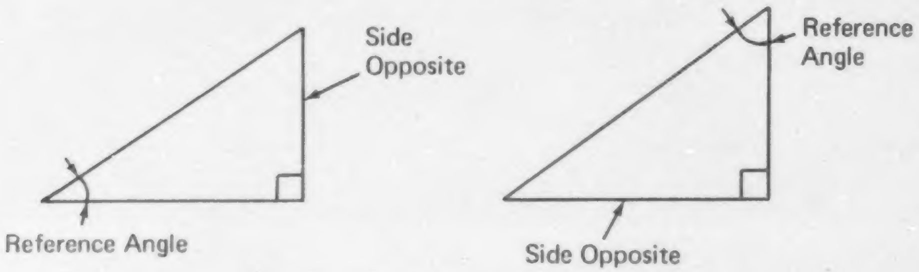

2"
1"
1"
4"
2"
7"
Overall Length

$$TO = \frac{0.250" \times 7"}{2}$$
$$= 0.875"$$

III. Sides of right triangles (Figures 10-12; Assignment Sheet #2)

A. Side opposite

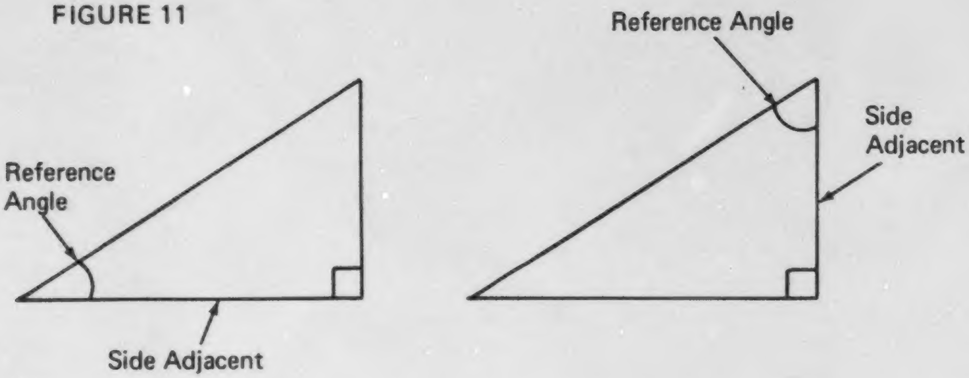
FIGURE 10


Side Opposite
Reference Angle
Reference Angle
Side Opposite

INFORMATION SHEET

B. Side adjacent

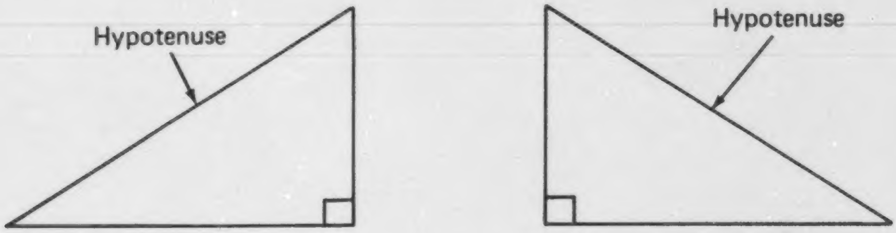
FIGURE 11


Reference Angle
Side Adjacent
Reference Angle
Side Adjacent

C. Hypotenuse

(NOTE: The hypotenuse is always the longest side of a triangle.)

FIGURE 12


Hypotenuse
Hypotenuse

IV. Calculating trigonometric functions of angles (Assignment Sheet #4)

(NOTE: Although there are six trigonometric functions, only three of them will be considered in this unit. Trigonometric ratios are normally expressed in decimals carried out from four to six places.)

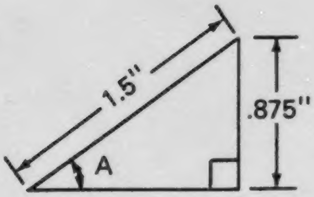
INFORMATION SHEET

A. Sine--Determined by dividing length of side opposite by length of hypotenuse (Figure 13)

EXAMPLE: $\text{Sine} \angle = \frac{\text{Side Opposite}}{\text{Hypotenuse}}$

$$\text{Sine A} = \frac{0.875}{1.5} = 0.58333$$

FIGURE 13

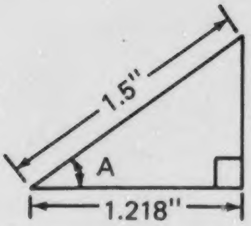


B. Cosine--Determined by dividing length of side adjacent by length of hypotenuse (Figure 14)

EXAMPLE: $\text{Cosine} \angle = \frac{\text{Side Adjacent}}{\text{Hypotenuse}}$

$$\text{Cosine A} = \frac{1.218}{1.5} = 0.8120$$

FIGURE 14



INFORMATION SHEET

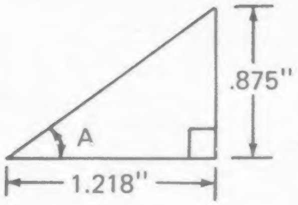
C. Tangent--Determined by dividing length of side opposite by length of side adjacent (Figure 15)

EXAMPLE: $\text{Tangent } \angle = \dfrac{\text{Side Opposite}}{\text{Side Adjacent}}$

$$\text{Tangent A} = \frac{0.875}{1.218}$$

$$= 0.71839$$

FIGURE 15



V. Determining angles, using trigonometric function tables (Assignment Sheet #3)

(NOTE: Having calculated the trigonometric functions of an angle, the measurement of that angle can be determined by referring to a table of trigonometric functions. See Figure 16.)

A. Find name of known function (sine, cosine, or tangent) at top or bottom of trigonometric function table

(NOTE: Most trigonometric tables are read down, using the column headings at the top for angles from 0° 0' to 44° 59' [60' = 1°]. The trigonometric function names for angles from 45° 0' to 89° 59' are listed at the bottom of the columns and must be read up.)

B. Look through table until you find the value of the function

C. Determine angle measurement

1. If the exact value is listed in the table, the angle measurement in degrees and minutes will be given beside the value (Figure 16, Examples a and b)

INFORMATION SHEET

2. If the exact value is not given in the table, use the angle measurement listed beside the value closest to the known function (Figure 16, Example c)

EXAMPLES:

a. Sine $\angle = 0.12360, \angle = 7^\circ\ 6'$
b. Sine $\angle = 0.99098, \angle = 82^\circ\ 18'$
c. Tangent $\angle = 7.3374, \angle \cong 82^\circ\ 14'$

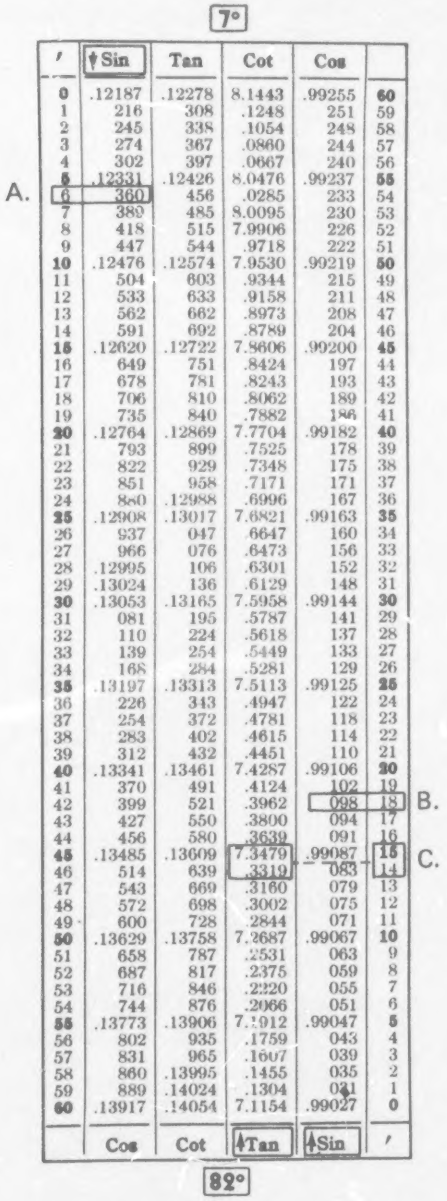
(NOTE: In Example c, 7.3374 falls between the tangent of 82° 14' [7.3319] and the tangent of 82° 15' [7.3479]. However, the value is closer to the tangent of 82° 14'.)

EXAMPLE:	Value	7.3374
	Tangent 82° 14'	- 7.3319
		0.0055
	Tangent 82° 15'	7.3479
	Value	- 7.3374
		0.0105

INFORMATION SHEET

FIGURE 16

Typical Page of Trigonometric Functions Table



7°

′	Sin	Tan	Cot	Cos	
0	.12187	.12278	8.1443	.99255	60
1	216	308	.1248	251	59
2	245	338	.1054	248	58
3	274	367	.0860	244	57
4	302	397	.0667	240	56
5	.12331	.12426	8.0476	.99237	55
6	360	456	.0285	233	54
7	389	485	8.0095	230	53
8	418	515	7.9906	226	52
9	447	544	.9718	222	51
10	.12476	.12574	7.9530	.99219	50
11	504	603	.9344	215	49
12	533	633	.9158	211	48
13	562	662	.8973	208	47
14	591	692	.8789	204	46
15	.12620	.12722	7.8606	.99200	45
16	649	751	.8424	197	44
17	678	781	.8243	193	43
18	706	810	.8062	189	42
19	735	840	.7882	186	41
20	.12764	.12869	7.7704	.99182	40
21	793	899	.7525	178	39
22	822	929	.7348	175	38
23	851	958	.7171	171	37
24	880	.12988	.6996	167	36
25	.12908	.13017	7.6821	.99163	35
26	937	047	.6647	160	34
27	966	076	.6473	156	33
28	.12995	106	.6301	152	32
29	.13024	136	.6129	148	31
30	.13053	.13165	7.5958	.99144	30
31	081	195	.5787	141	29
32	110	224	.5618	137	28
33	139	254	.5449	133	27
34	168	284	.5281	129	26
35	.13197	.13313	7.5113	.99125	25
36	226	343	.4947	122	24
37	254	372	.4781	118	23
38	283	402	.4615	114	22
39	312	432	.4451	110	21
40	.13341	.13461	7.4287	.99106	20
41	370	491	.4124	102	19
42	399	521	.3962	098	18
43	427	550	.3800	094	17
44	456	580	.3639	091	16
45	.13485	.13609	7.3479	.99087	15
46	514	639	.3319	083	14
47	543	669	.3160	079	13
48	572	698	.3002	075	12
49	600	728	.2844	071	11
50	.13629	.13758	7.2687	.99067	10
51	658	787	.2531	063	9
52	687	817	.2375	059	8
53	716	846	.2220	055	7
54	744	876	.2066	051	6
55	.13773	.13906	7.1912	.99047	5
56	802	935	.1759	043	4
57	831	965	.1607	039	3
58	860	.13995	.1455	035	2
59	889	.14024	.1304	031	1
60	.13917	.14054	7.1154	.99027	0
	Cos	Cot	Tan	Sin	′

82°

INFORMATION SHEET

VI. Determining trigonometric functions of angles (Assignment Sheet #3)

A. Locate angle measurement in trigonometric function table

B. Determine value of a particular function by checking proper column heading for that function (Figure 17)

(NOTE: Remember that function headings for angles from 0° 0' to 44° 59' are listed at the top of the table, while those for angles from 45° 0' to 89° 59' are listed at the bottom.)

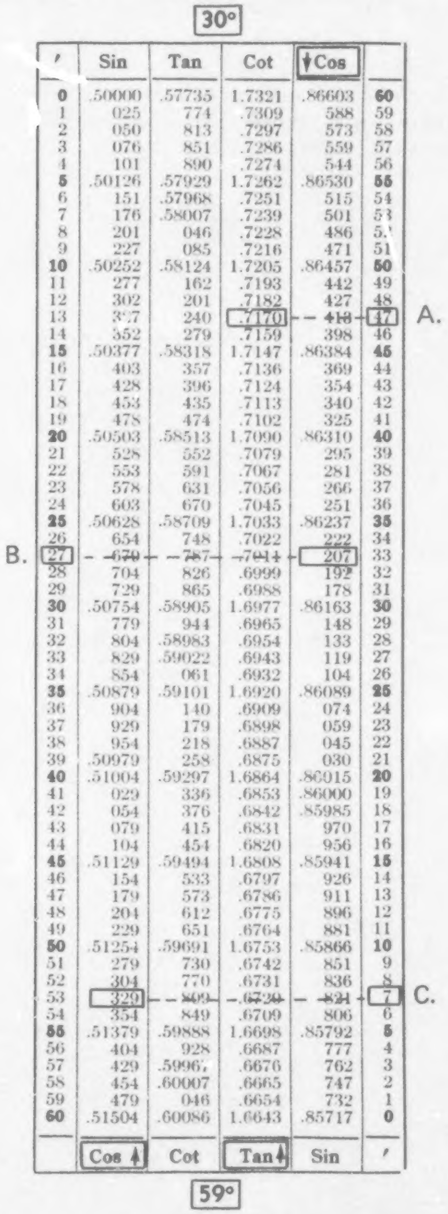
EXAMPLES:

a. Tangent 59° 47' = 1.7170
b. Cosine 30° 27' = 0.86207
c. Cosine 59° 7' = 0.51329

INFORMATION SHEET

FIGURE 17

Typical Page of Trigonometric Functions Table



30°

	′	Sin	Tan	Cot	Cos		
	0	.50000	.57735	1.7321	.86603	**60**	
	1	025	774	.7309	588	59	
	2	050	813	.7297	573	58	
	3	076	851	.7286	559	57	
	4	101	890	.7274	544	56	
	5	.50126	.57929	1.7262	.86530	**55**	
	6	151	.57968	.7251	515	54	
	7	176	.58007	.7239	501	53	
	8	201	046	.7228	486	52	
	9	227	085	.7216	471	51	
	10	.50252	.58124	1.7205	.86457	**50**	
	11	277	162	.7193	442	49	
	12	302	201	.7182	427	48	
	13	327	240	.7170	413	47	A.
	14	352	279	.7159	398	46	
	15	.50377	.58318	1.7147	.86384	**45**	
	16	403	357	.7136	369	44	
	17	428	396	.7124	354	43	
	18	453	435	.7113	340	42	
	19	478	474	.7102	325	41	
	20	.50503	.58513	1.7090	.86310	**40**	
	21	528	552	.7079	295	39	
	22	553	591	.7067	281	38	
	23	578	631	.7056	266	37	
	24	603	670	.7045	251	36	
	25	.50628	.58709	1.7033	.86237	**35**	
	26	654	748	.7022	222	34	
B.	27	679	787	.7011	207	33	
	28	704	826	.6999	192	32	
	29	729	865	.6988	178	31	
	30	.50754	.58905	1.6977	.86163	**30**	
	31	779	944	.6965	148	29	
	32	804	.58983	.6954	133	28	
	33	829	.59022	.6943	119	27	
	34	854	061	.6932	104	26	
	35	.50879	.59101	1.6920	.86089	**25**	
	36	904	140	.6909	074	24	
	37	929	179	.6898	059	23	
	38	954	218	.6887	045	22	
	39	.50979	258	.6875	030	21	
	40	.51004	.59297	1.6864	.86015	**20**	
	41	029	336	.6853	.86000	19	
	42	054	376	.6842	.85985	18	
	43	079	415	.6831	970	17	
	44	104	454	.6820	956	16	
	45	.51129	.59494	1.6808	.85941	**15**	
	46	154	533	.6797	926	14	
	47	179	573	.6786	911	13	
	48	204	612	.6775	896	12	
	49	229	651	.6764	881	11	
	50	.51254	.59691	1.6753	.85866	**10**	
	51	279	730	.6742	851	9	
	52	304	770	.6731	836	8	
	53	329	809	.6720	821	7	C.
	54	354	849	.6709	806	6	
	55	.51379	.59888	1.6698	.85792	**5**	
	56	404	928	.6687	777	4	
	57	429	.59967	.6676	762	3	
	58	454	.60007	.6665	747	2	
	59	479	046	.6654	732	1	
	60	.51504	.60086	1.6643	.85717	**0**	
		Cos	Cot	Tan	Sin	′	

59°

INFORMATION SHEET

VII. Calculating sides of right triangles (Assignment Sheet #4)

(NOTE: To calculate the length of a side of a right triangle, you must know the length of one of the sides and the value of one angle other than the right angle.)

A. Identify side to be calculated in relation to a known reference angle (side adjacent, side opposite, or hypotenuse)

B. Use one of the formulas listed on the chart

UNKNOWN		KNOWN
Length of Hypotenuse	=	Length of Side Opposite ÷ Sine ∠
		or
	=	Length of Side Adjacent ÷ Cosine ∠
Length of Side Opposite	=	Length of Hypotenuse x Sine ∠
		or
	=	Length of Side Adjacent x Tangent ∠
Length of Side Adjacent	=	Length of Hypotenuse x Cosine ∠
		or
	=	Length of Side Opposite ÷ Tangent ∠

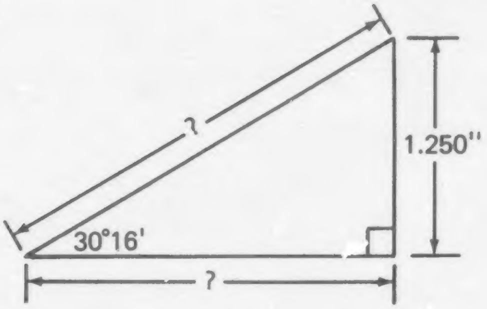
C. Use trigonometric function table to determine the value of the required function

INFORMATION SHEET

D. Perform the indicated mathematics with the proper values (Figure 18)

EXAMPLE:

FIGURE 18



To determine the length of the side adjacent when the angle and the side opposite are known--

Length of Side Adjacent = Length of Side Opposite ÷ Tangent of ∠
= 1.250" ÷ 0.58357
= 2.142"

To determine the length of the hypotenuse when the angle and the side opposite are known--

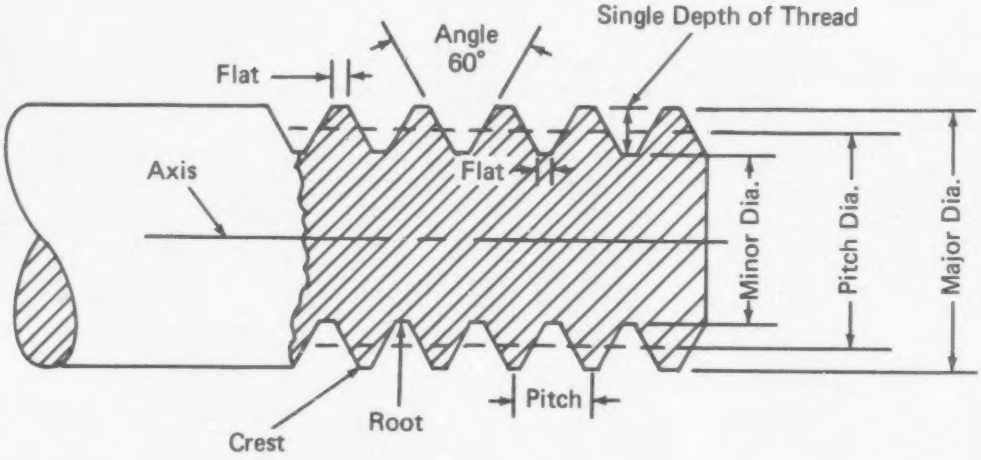
Length of Hypotenuse = Length of Side Opposite ÷ Sine of ∠
= 1.250" ÷ 0.50402
= 2.480"

(NOTE: The trigonometric functions for this angle are listed in Figure 17.)

INFORMATION SHEET

VIII. Parts of American National thread form (Figure 19)

FIGURE 19


Angle
60°
Single Depth of Thread
Flat
Axis
Flat
Minor Dia.
Pitch Dia.
Major Dia.
Pitch
Root
Crest

A. Major diameter

B. Pitch diameter

C. Minor diameter

D. Pitch

E. Root

F. Crest

G. Axis

H. Flat

I. Angle

J. Single depth of thread

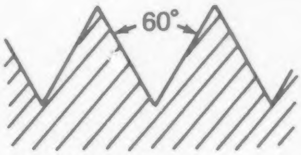
INFORMATION SHEET

IX. Thread forms (Figures 20-27)

A. Sharp "V"

(NOTE: The sharp-V thread form is not used much today because it is easily damaged.)

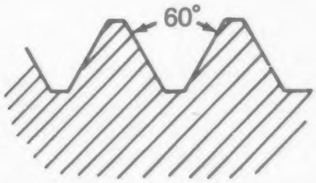
FIGURE 20



B. American National

(NOTE: American National thread form is used extensively in today's industries.)

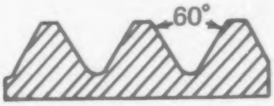
FIGURE 21



C. Unified

(NOTE: Unified thread form is used as a standard form in the United States, Canada, and Great Britain.)

FIGURE 22

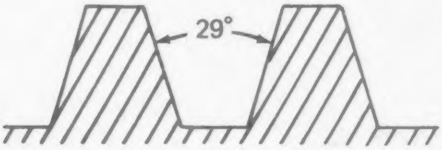


INFORMATION SHEET

D. Acme

(NOTE: Acme thread form is very strong and is a modified square thread.)

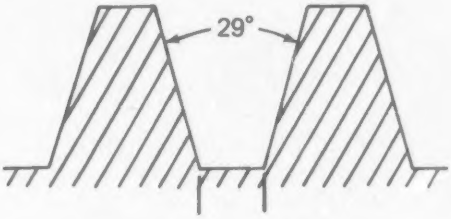
FIGURE 23



E. Brown and Sharpe worm

(NOTE: The Brown and Sharpe worm thread form is similar to an Acme thread in appearance, yet has a deeper thread and is another form of a modified square thread.)

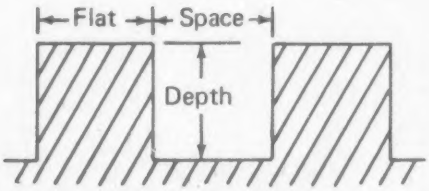
FIGURE 24



F. Square

(NOTE: The flat, space, and depth of the square thread are all equal.)

FIGURE 25

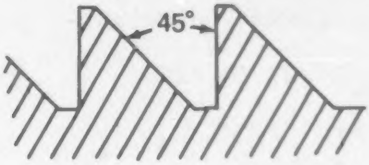


INFORMATION SHEET

G. Buttress

(NOTE: The buttress thread form has great strength in one direction.)

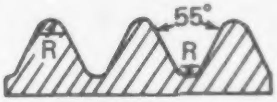
FIGURE 26



H. Whitworth

(NOTE: This thread has a 55° thread angle with a radius at crest and root.)

FIGURE 27



X. Formulas used to calculate dimensions for American National form

(NOTE: Formulas for calculating the dimensions of threads vary with each form. Refer to appropriate handbooks to determine other required formulas.)

A. Pitch (P)--$P = \dfrac{1}{\text{Number of threads per inch (N)}}$

EXAMPLE: To determine the pitch of a bolt with 20 American National form threads per inch--

$$P = \frac{1}{N}$$

$$= \frac{1}{20}$$

$$= 0.050''$$

INFORMATION SHEET

B. Single depth of thread (D)--$D = 0.6495 \times P$ or $D = \frac{0.6495}{N}$

(NOTE: The number 0.6495 is a constant for the ratio of the pitch to the depth of the American National form.)

EXAMPLE: To determine the single depth of thread for a bolt with 20 American National form threads per inch--

$$D = 0.6495 \times P$$

$$= 0.6495 \times 0.050''$$

$$= 0.033''$$

or

$$= \frac{0.6495}{N}$$

$$= \frac{0.6495}{20}$$

$$= 0.033''$$

C. Width of flat (F)--$F = 0.125 \times P$ or $F = \frac{0.125}{N}$

(NOTE: The number 0.125 is a constant for the ratio of the pitch to the flat of the American National form.)

EXAMPLE: To determine the width of a flat on a bolt with 20 American National form threads per inch--

$$F = 0.125 \times P$$

$$F = 0.125 \times 0.050''$$

$$F = 0.006''$$

or

$$F = \frac{0.125}{N}$$

$$= \frac{0.125}{20}$$

$$= 0.006''$$

INFORMATION SHEET

D. Compound feed depth (C)--C = 0.75 x P or $C = \frac{0.75}{N}$

(NOTE: The number 0.75 represents the percent of thread engagement for American National form.)

EXAMPLE: To determine the compound feed depth for cutting a bolt with 20 American National form threads per inch (Figure 28)--

$$C = \frac{0.75}{N}$$

$$= \frac{0.75}{20}$$

$$= 0.0375''$$

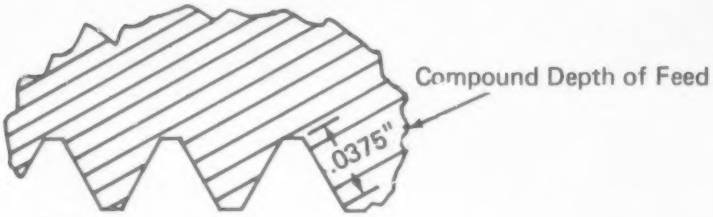
or

$$C = 0.75 \times P$$

$$= 0.75 \times 0.05''$$

$$= 0.0375''$$

FIGURE 28



XI. Methods of measuring thread pitch diameters

(NOTE: Pitch diameters for using screw pitch micrometers are in machinery handbooks; using thread triangles or three-wire requires calculations.)

A. Screw pitch micrometer

B. Thread triangles with standard micrometer

C. Three-wire with standard micrometer

D. Thread snap gauges

E. Plug on ring gauges

ENGINE LATHE OPERATIONS
UNIT III

ASSIGNMENT SHEET #1--USE SHOP FORMULAS TO CALCULATE TAPER DIMENSIONS

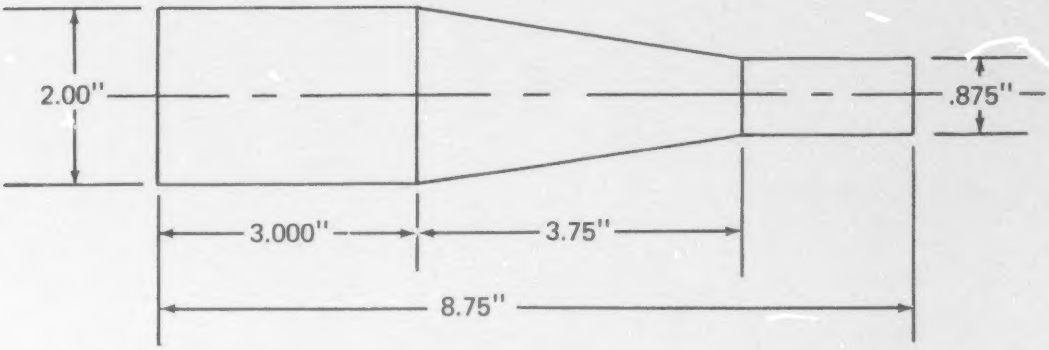
NAME ______________________________ SCORE ______________

Many times the machinist is required to turn a taper; usually it is up to the machinist to calculate the taper.

Determine taper dimensions for the following problems. Give answers in ten-thousandths of an inch and show your work.

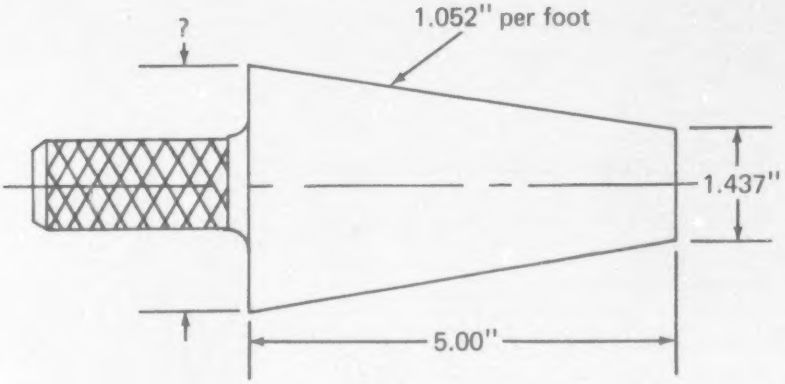
A. What is the taper per foot of the part illustrated below?

Taper per foot = ____________________



B. What is the diameter of the large end of the taper plug gauge illustrated below?

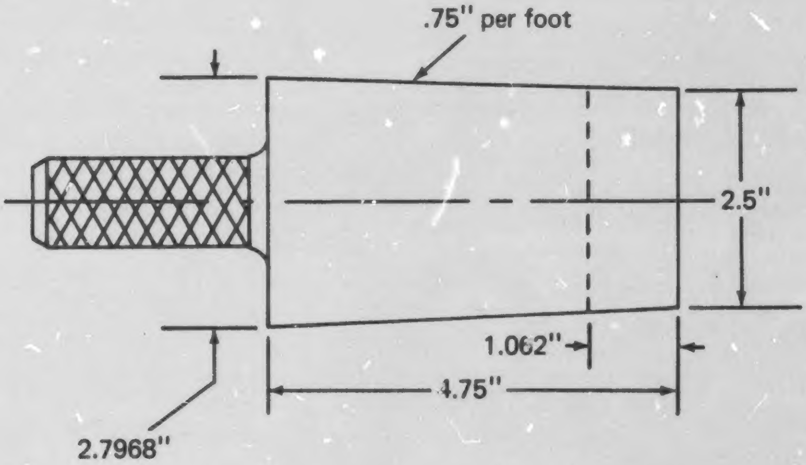
Diameter = ____________________



ASSIGNMENT SHEET #1

C. If the plug gauge shown below fits in a mating taper, and the small end extends 1.062" through the taper, what is the diameter at that point?

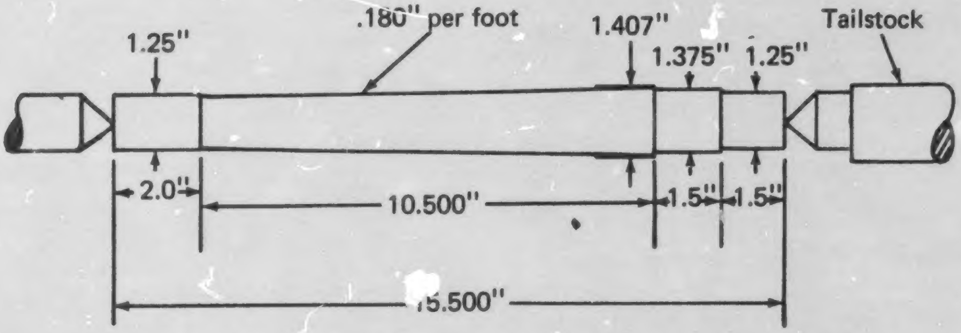
Diameter = ______________________________


.75" per foot
2.5"
1.062"
4.75"
2.7968"

D. How much must the tailstock offset be in order to machine the part shown below? Is the tailstock offset toward or away from you?

1. What is the offset? ______________________________

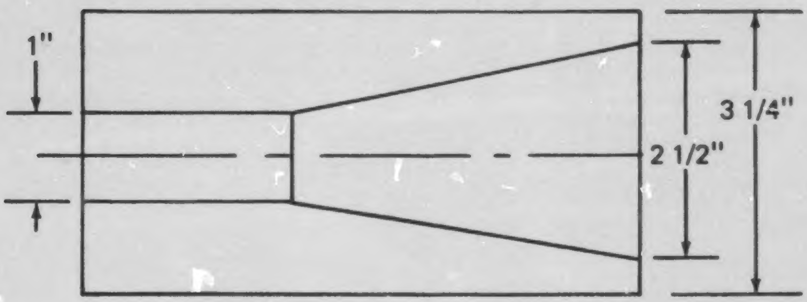
2. Which way is it moved? ______________________________


.180" per foot
1.25"
1.407"
1.375"
1.25"
Tailstock
2.0"
10.500"
1.5"
1.5"
15.500"

ASSIGNMENT SHEET #1

E. What is the total taper of the part below?

Total taper = ____________________



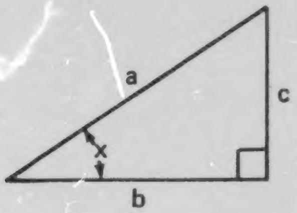
ENGINE LATHE OPERATIONS
UNIT III

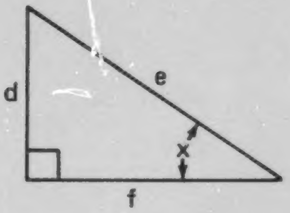
ASSIGNMENT SHEET #2--LABEL SIDES OF RIGHT TRIANGLES

NAME ______________________________ SCORE ______________

The more familiar you become with the parts of a right triangle, the easier it will be to determine which formula to use in your calculations.

Name the sides of the following right triangles using ∠X as the reference angle. Write "Hyp" for hypotenuse, "Adj" for side adjacent, and "Opp" for side opposite in the blanks.





A. 1. a = ______________

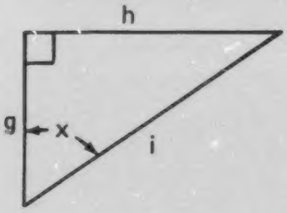
2. b = ______________

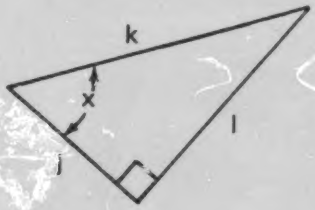
3. c = ______________

B. 1. d = ______________

2. e = ______________

3. f = ______________





C. 1. g = ______________

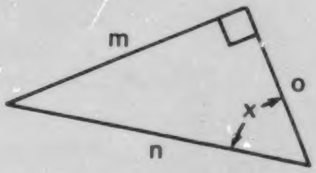
2. h = ______________

3. i = ______________

D. 1. j = ______________

2. k = ______________

3. l = ______________



E. 1. m = ______________

2. n = ______________

3. o = ______________

ENGINE LATHE OPERATIONS
UNIT III

ASSIGNMENT SHEET #3--USE TRIGONOMETRIC FUNCTION TABLES

NAME ____________________________ SCORE ____________

Often the error made in calculation of sides or angles of right triangles is made by misreading the trigonometric function tables. Use the tables in the *Handy Multipliers and Trigonometry Tables for Engineers* to determine the functions below.

A. Write the numerical value of specified function for the following angles.

1. Sine 19° = ____________
2. Tangent 36° = ____________
3. Cosine 10° = ____________
4. Tangent 63° = ____________
5. Cosine 74° = ____________
6. Sine 60°15' = ____________
7. Tangent 15°45' = ____________
8. Cosine 50°39' = ____________
9. Sine 37°18' = ____________
10. Tangent 54°50' = ____________

B. Write the value of the angles that correspond to the following functions.

1. Tangent ∠ ________________ = 0.17993
2. Cosine ∠ ________________ = 0.90875
3. Sine ∠ ________________ = 0.82231
4. Cosine ∠ ________________ = 0.68624
5. Sine ∠ ________________ = 0.14349
6. Tangent ∠ ________________ = 14.924
7. Sine ∠ ________________ = 0.45062
8. Cosine ∠ ________________ = 0.76361
9. Tangent ∠ ________________ = 2.3984
10. Sine ∠ ________________ = 0.07237

ENGINE LATHE OPERATIONS
UNIT III

ASSIGNMENT SHEET #4--CALCULATE SIDES AND ANGLES OF RIGHT TRIANGLES

NAME ______________________________ SCORE ______________

It is often necessary to calculate sides or angles of right triangles in order to make parts.

A. List the formulas to find the sides indicated by "X," using the indicated angle as the reference angle. If either of two formulas could be used to find the value "X," give both of them.

Hypotenuse = Opposite ÷ Sine ∠

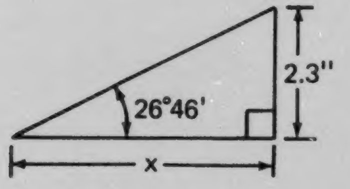
Adjacent = Opposite ÷ Tangent ∠

Opposite = Hypotenuse x Sine ∠

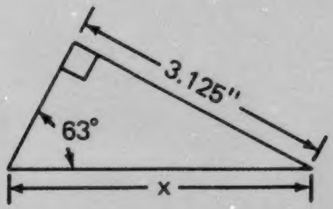
Hypotenuse = Adjacent ÷ Cosine ∠

Adjacent = Hypotenuse x Cosine ∠

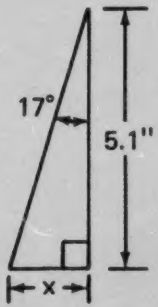
Opposite = Adjacent x Tangent ∠



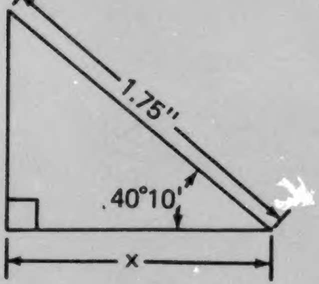
1. ______________________



2. ______________________

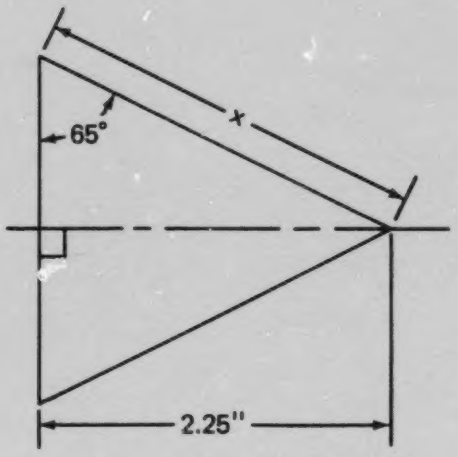


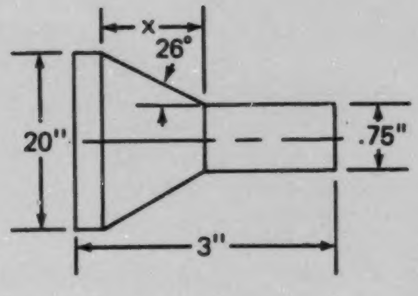
3. ______________________



4. ______________________

ASSIGNMENT SHEET #4



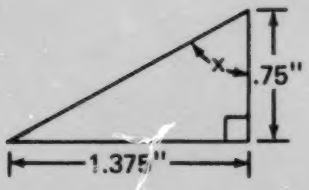


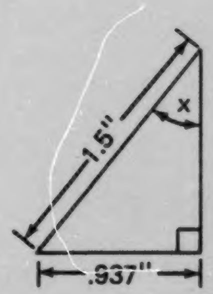
5. ____________________

6. ____________________

B. List the formula necessary to find the angle indicated by "X."

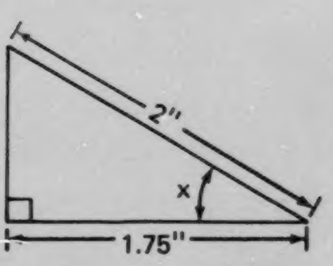
$\text{Sine} \angle = \dfrac{\text{Opposite}}{\text{Hypotenuse}}$ $\text{Cosine} \angle = \dfrac{\text{Adjacent}}{\text{Hypotenuse}}$ $\text{Tangent} \angle = \dfrac{\text{Opposite}}{\text{Adjacent}}$

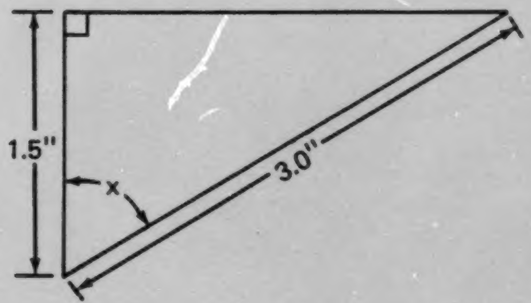




1. ____________________

2. ____________________

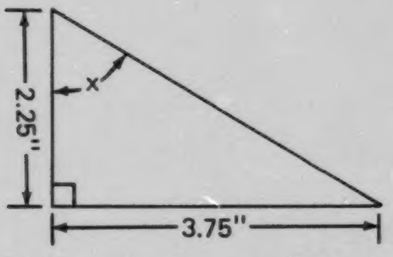


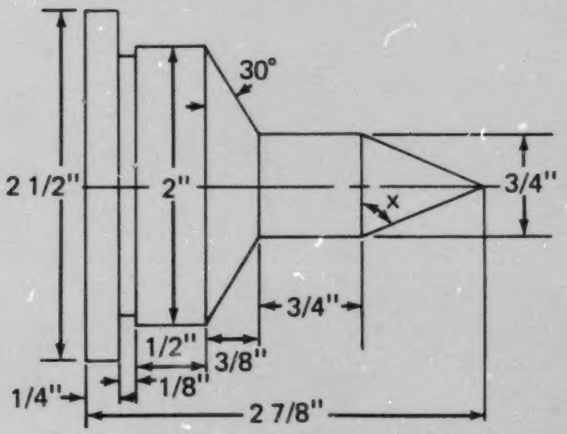


3. ____________________

4. ____________________

ASSIGNMENT SHEET #4

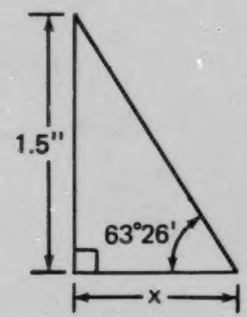



30°
2 1/2"
2"
x
3/4"
3/4"
1/2"
3/8"
1/8"
1/4"
2 7/8"

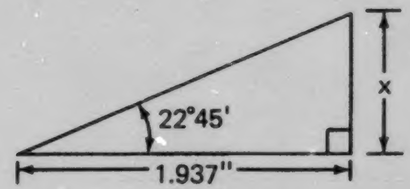
5. ____________________

6. ____________________

C. Calculate the length of the sides indicated by "X." Round decimals to three places and show all work.

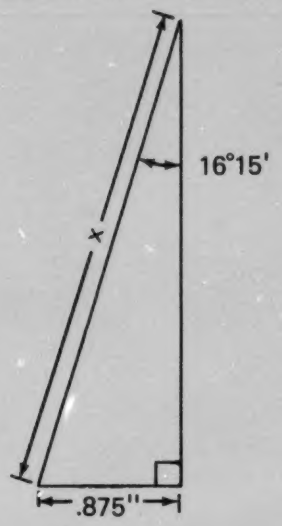


1. X = ____________________

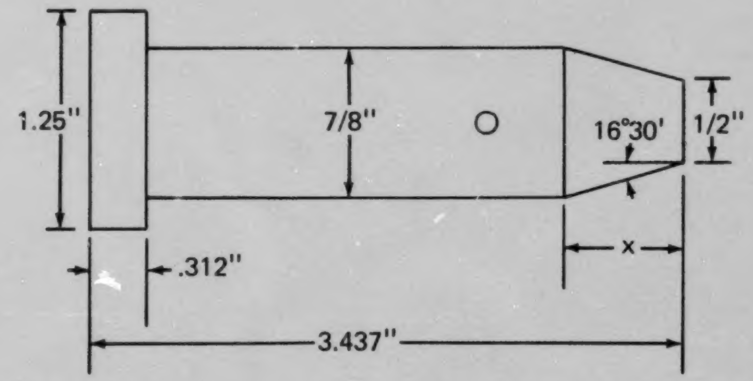


2. X = ____________________

ASSIGNMENT SHEET #4

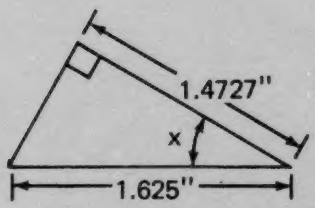


3. X = ________________


1.25"
7/8"
16°30'
1/2"
.312"
x
3.437"

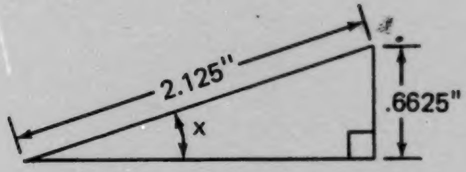
4. X = ________________

D. Calculate the angles indicated by "X" in the following right triangles. Show all work. List answers to the nearest minute.

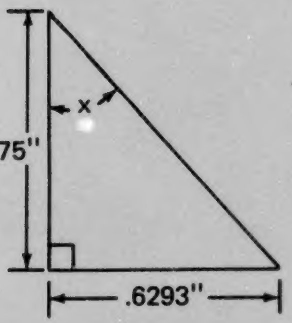

1.4727"
x
1.625"

1. X = ________________

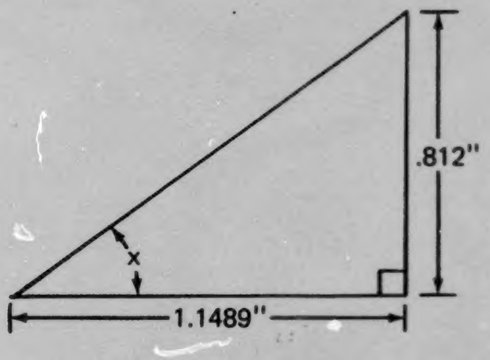
ASSIGNMENT SHEET #4



2. X = ________________

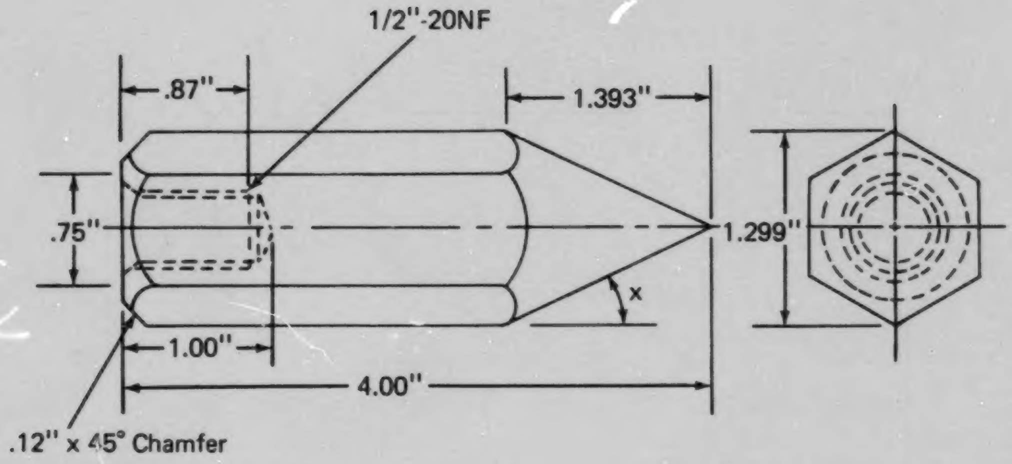


3. X = ________________



4. X = ________________

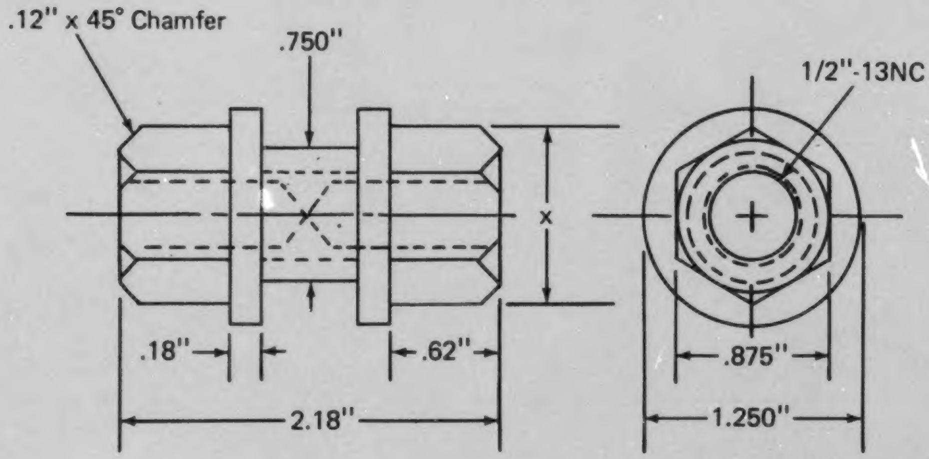
ASSIGNMENT SHEET #4


1/2"-20NF
.87"
1.393"
.75"
1.299"
x
1.00"
4.00"
.12" x 45° Chamfer

5. X = ______________

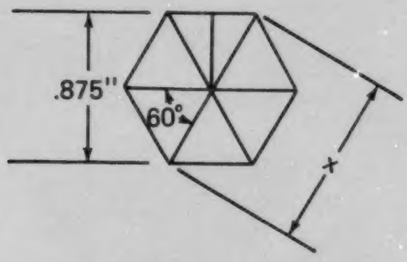
ASSIGNMENT SHEET #4

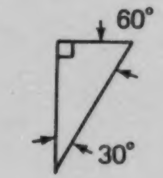
E. Calculate the length of X (diagonal of the hexagon).


.12" x 45° Chamfer
.750"
1/2"-13NC
x
.18"
.62"
2.18"
.875"
1.250"

X = ____________________

Hint:





ENGINE LATHE OPERATIONS
UNIT III

ASSIGNMENT SHEET #5--PLAN PRODUCTION OPERATIONS

NAME ______________________________ SCORE ______________

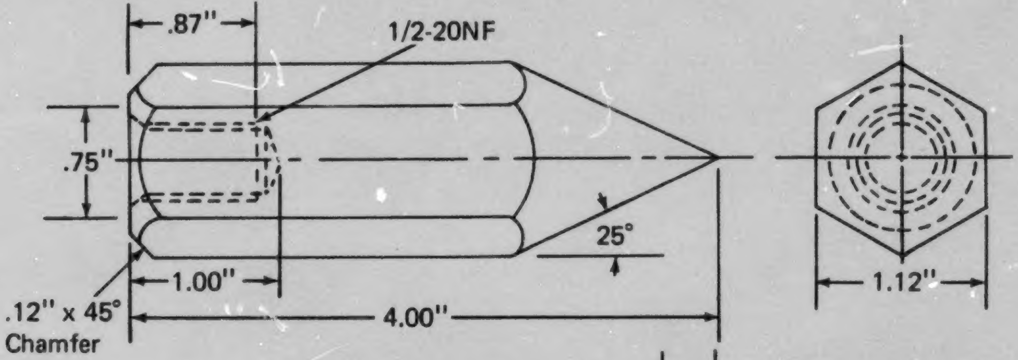
Developing the skills to plan step-by-step production is a must in becoming a machinist.

(NOTE: Complete this assignment sheet after completion of all job sheets.)

A. Examine the blueprint below and check the cutting tools, measuring tools, and setup tools that would be required to make this plumb bob on an engine lathe.

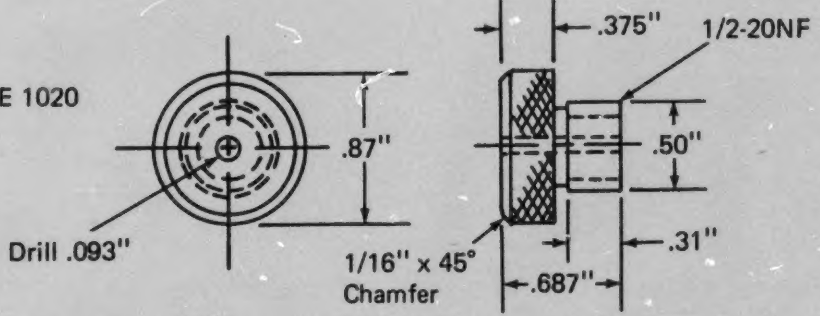
Part A

Material: Hex Steel SAE 1020 5 inches long


.87"
1/2-20NF
.75"
25°
1.00"
.12" x 45°
Chamfer
4.00"
1.12"

Part B

Material: SAE 1020


.375"
1/2-20NF
.87"
.50"
Drill .093"
1/16" x 45°
Chamfer
.31"
.687"

_____ 1. Center drill, #3

_____ 2. Micrometer, 1" to 2"

_____ 3. Center gauge

_____ 4. Micrometer, 0" to 1"

_____ 5. Drill, 1/2"

_____ 6. Turning tool

_____ 7. Recessing tool

_____ 8. Protractor

_____ 9. Treading tool

_____ 10. Knurling tool

_____ 11. Drill, 3/32"

_____ 12. Drill, 27/64"

_____ 13. Facing tool

_____ 14. Tap, 1/2" 20-NF

_____ 15. Countersink, 3/4"

_____ 16. Tap handle

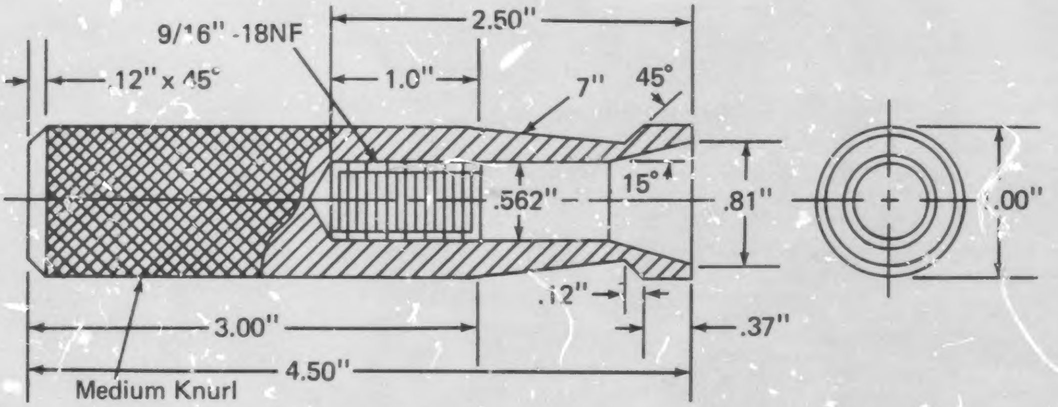
_____ 17. Cutoff tool

_____ 18. Vernier calipers

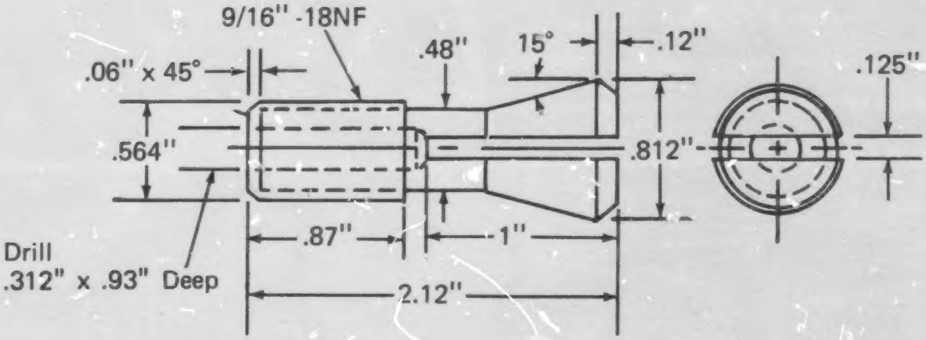
ASSIGNMENT SHEET #5

B. Examine the blueprint below, and then write an "X" in the blanks before the lathe operations required to make this file handle.

Part A Material: 2024T4 Aluminum


9/16" -18NF
2.50"
.12" x 45°
1.0"
7"
45°
15°
.562"
.81"
.00"
.12"
3.00"
.37"
4.50"
Medium Knurl

Part B
Material: 2024T4 Aluminum
1" Round Bar 7 3/4" Long


9/16" -18NF
.06" x 45°
.48"
15°
.12"
.125"
.564"
.812"
.87"
1"
2.12"
Drill
.312" x .93" Deep

_____ 1. Taper turning

_____ 2. Facing

_____ 3. Straight turning

_____ 4. Forming

_____ 5. Cutting internal threads

_____ 6. Center drilling

_____ 7. Drilling 9/16" hole

_____ 8. Drilling 5/16" hole

_____ 9. Chamfering

_____ 10. Taper boring 15"

_____ 11. Knurling

_____ 12. Tapping

_____ 13. Cutting external threads

_____ 14. Cutoff

_____ 15. Drilling 33/64" hole

_____ 16. Taper turning 15°

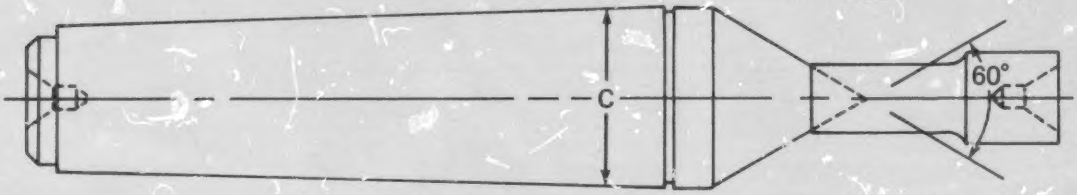
_____ 17. Taper turning 45°

_____ 18. Recessing

ASSIGNMENT SHEET #5

C. Examine the blueprint of the dead center. Then write an "X" in the blanks before the lathe attachments and work-holding devices used to make the part illustrated below.

(NOTE: Material is SAE 1095, steel rod.)



_____ 1. Four-jaw chuck

_____ 2. Three-jaw chuck

_____ 3. Collet attachment

_____ 4. Drill chuck

_____ 5. Live center for tailstock

_____ 6. Lathe dog

_____ 7. Follower rest

_____ 8. Taper attachment

_____ 9. Drive plate and spindle adapter

_____ 10. Dead center

_____ 11. Face place

D. Arrange in order the steps required to make the flange nuts from the drawing on the following page.

(NOTE: The steps listed are for lathe work only. Disregard the hex finish.)

Center drill
Turn to 1.008" diameter x 0.62"
Tap 1/2" -13 NC x 3/4" deep
Turn end for end
Face
Drill 27/64" x 1 3/32" deep
Cut recess 0.125" x 0.025" deep
Face
Drill 27/64" x 1 3/32" deep

Center drill
Turn to 1.008" diameter x 0.62"
Chamfer 0.12 x 45°
File sharp edges
Cut recess 0.125" x 0.25" deep
Tap 1/2" -13 NC x 3/4" deep
File sharp edges
Chamfer 0.12" x 45°
Chuck

1. ____________________

2. ____________________

3. ____________________

ASSIGNMENT SHEET #5

4. ______________________________

5. ______________________________

6. ______________________________

7. ______________________________

8. ______________________________

9. ______________________________

10. ______________________________

11. ______________________________

12. ______________________________

13. ______________________________

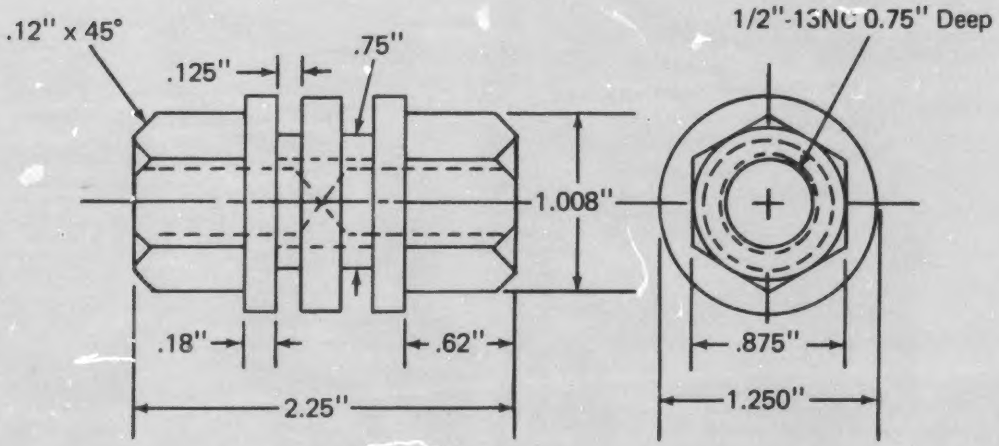
14. ______________________________

15. ______________________________

16. ______________________________

17. ______________________________

18. ______________________________


.12" x 45°
.125"
.75"
1/2"-13NC 0.75" Deep
1.008"
.18"
.62"
2.25"
.875"
1.250"

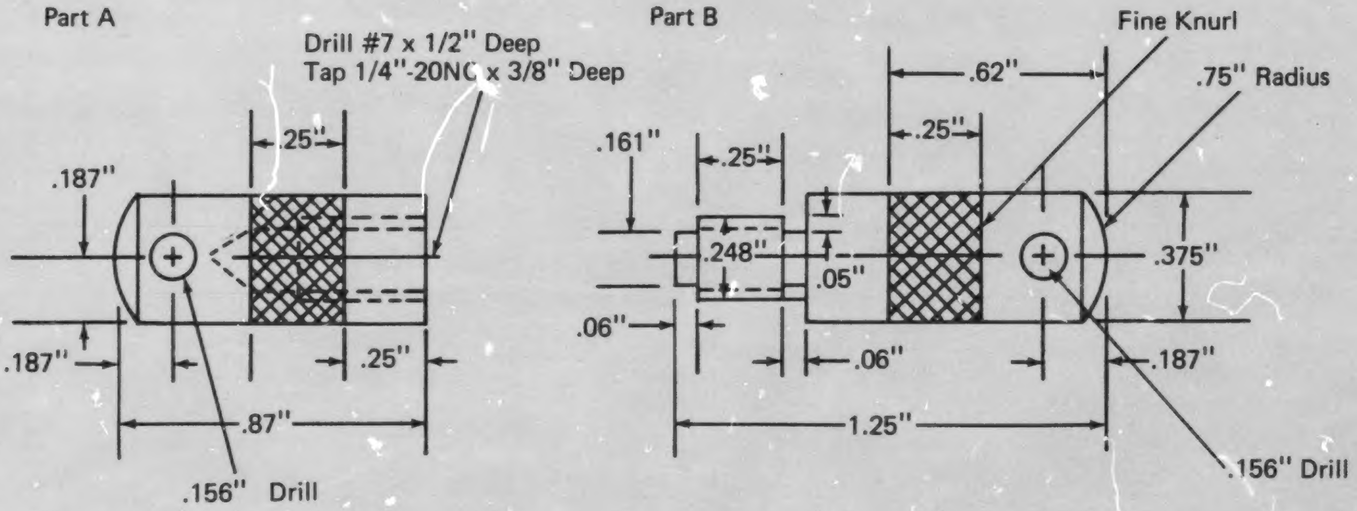
Material--1 1/4" steel bar, SAE 1140
Sawed length 2 3/8"

ASSIGNMENT SHEET #5

E. Write the step-by-step sequence of lathe operations that would be required to make the keyring, starting with part A. Listed below are the tools, supplies, and equipment that you would need to make the keyring. Lathe with collet chuck, drill chuck, and tool post and holder. (See next page.)

Cutoff blade and holder
RH turning tool
File, 8" mill
Radius gauge, 3/4"
Hermaphrodite calipers
Material--3/8" aluminum bar, 2024T4 x 10"
Center gauge
Drill, #7
Tap, 1/4" 20NC (plug)
Combination drill and countersink, #3
Steel rule, 6"
Micrometer, 0" to 1"
Knurling tool (fine)
RH facing tool
Recessing tool
Cutting oil
RH threading tool

ASSIGNMENT SHEET #5


Part A
Drill #7 x 1/2" Deep
Tap 1/4"-20NC x 3/8" Deep
.25"
.187"
.187"
.25"
.87"
.156" Drill
Part B
Fine Knurl
.62"
.75" Radius
.161"
.25"
.25"
.248"
.05"
.375"
.06"
.06"
.187"
1.25"
.156" Drill

PROJECT NAME			DATE
Keyring			7-15-77
DRAWN By J. Dunn	CHECKED By J. D.		
SHEET No. 1	No. OF SHEETS 1		SCALE 1/1
TOLERANCE	Decs. xx = .010	.xxx = .002	ANG = ±30'

(NOTE: Drilling 0.156" holes will be done on drill press.)

ENGINE LATHE OPERATIONS
UNIT III

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

A. 3.6" per foot

B. 1.8795"

C. 2.5663"

D. 1. 0.11625"
   2. Away

E. 1.5"

Assignment Sheet #2

A.
  1. Hyp
  2. Adj
  3. Opp

B.
  1. Opp
  2. Hyp
  3. Adj

C.
  1. Adj
  2. Opp
  3. Hyp

D.
  1. Adj
  2. Hyp
  3. Opp

E.
  1. Opp
  2. Hyp
  3. Adj

Assignment Sheet #3

(NOTE: Answers may be ± .0001 of those given.)

A.
  1. 0.32557
  2. 0.72654
  3. 0.98481
  4. 1.9626
  5. 0.27564
  6. 0.86820
  7. 0.28203
  8. 0.63405
  9. 0.60599
  10. 1.4193

B.
  1. 10° 12'
  2. 24° 40'
  3. 55° 19'
  4. 46° 40'
  5. 8° 15'
  6. 86° 10'
  7. 26° 47'
  8. 40° 13'
  9. 67° 22'
  10. 4° 9'

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #4

A. 1. Adjacent = Opposite ÷ Tangent ∠

2. Hypotenuse = Opposite ÷ Sine ∠

3. Opposite = Adjacent x Tangent ∠

4. Adjacent = Hypotenuse x Cosine ∠

5. Hypotenuse = Opposite ÷ Sine ∠

6. Adjacent = Opposite ÷ Tangent ∠

B. 1. $\text{Tangent}\angle = \dfrac{\text{Opposite}}{\text{Adjacent}}$

2. $\text{Sine}\angle = \dfrac{\text{Opposite}}{\text{Hypotenuse}}$

3. $\text{Cosine}\angle = \dfrac{\text{Adjacent}}{\text{Hypotenuse}}$

4. $\text{Cosine}\angle = \dfrac{\text{Adjacent}}{\text{Hypotenuse}}$

5. $\text{Tangent}\angle = \dfrac{\text{Opposite}}{\text{Adjacent}}$

6. $\text{Tangent}\angle = \dfrac{\text{Opposite}}{\text{Adjacent}}$

C. 1. 0.750"

2. 0.812"

3. 3.127"

4. 0.633"

D. 1. 25°

2. 18° 10'

3. 40°

4. 35° 15'

5. 25°

E. 1.0103"

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #5

(NOTE: Tools, equipment, and procedures may vary, depending on tools and equipment available and the instructor's preferences. The following are suggested answers.)

A. 1, 3, 4, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18

B. 1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

C. 2, 4, 5, 6, 8, 9, 10

D.
1. Chuck
2. Face
3. Turn to 1.008" dia. x 0.62"
4. Chamfer 0.12 x 45°
5. Center drill
6. Drill 27/64" x 1 3/32" deep
7. Tap 1/2"-13 NC x 3/4" deep
8. Cut recess 0.125" x 0.25" deep
9. File sharp edges
10. Turn end-for-end
11. Face
12. Turn to 1.008" dia. x 0.62"
13. Chamfer 0.12 x 45°
14. Center drill
15. Drill 27/64" x 1 3/32" deep
16. Tap 1/2" -13 NC x 3/4" deep
17. Cut recess 0.125" x 0.25" deep
18. File sharp edges

E.
1. Secure part in collet with 1 3/16" extending from end of collet
2. Face
3. Center drill
4. Drill #7 x 1/2" deep
5. Tap 1/4 -20 NC x 3/8" deep
6. Knurl (fine)
7. Cut off part 7/8" long
8. Loosen collet and slide part out 1 1/2"
9. Turn 0.248" diameter x 3/8" long
10. Cut 0.06" recesses 0.05" deep
11. Thread 1/4" -10 NC to fit part A
12. Knurl (fine)

ANSWERS TO ASSIGNMENT SHEETS

13. Screw on part A and file radius, then remove A
14. Cut off part B 1 1/4" long
15. Remove material from collet
16. Turn part B end-for-end and secure in collet
17. File radius
18. Remove part

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #1--REMOVE AND INSTALL A LATHE CHUCK

I. Equipment and materials

A. Board, 6" x 10" x 3/4"

B. Wrench for removing chuck

C. Wire thread-cleaning tool

D. Wire brush

E. Clean cloth

F. Oil can with light oil

G. Soft-faced mallet

H. Chuck wrench

I. Adjustable wrench

J. Suitable wrench for chuck

II. Procedure for removing chuck

(NOTE: With very few changes, these procedures will apply to any work-holding device mounted on the spindle.)

(CAUTION: Leave power off while removing and installing chuck.)

A. Threaded spindle nose

1. Adjust chuck jaws flush with outside of chuck

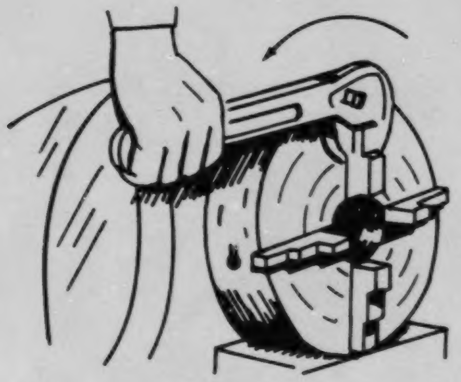
2. Engage lathe in back gear so that spindle will not turn easily

3. Place the board under the chuck to protect the ways

JOB SHEET #1

4. Place adjustable wrench over jaw and pull sharply in a counterclockwise direction (Figure 29)

FIGURE 29



(NOTE: Spindle has right-hand threads.)

5. Once chuck is loose, turn the rest of the way by hand

B. Tapered-nose spindle

1. Adjust jaws flush with outside of chuck

2. Engage lathe in back gear or low range

3. Place board under chuck

4. Place spanner wrench on threaded collar and hold so that wrench will not slip

5. Strike wrench sharply with palm of hand or soft-faced mallet away from you in a clockwise direction

6. Hold chuck with one hand and unscrew threaded ring with other hand

7. Use both hands to remove chuck

(CAUTION: Keep your hands in a position where they are never between the chuck and board. If chuck is large or heavy, get help.)

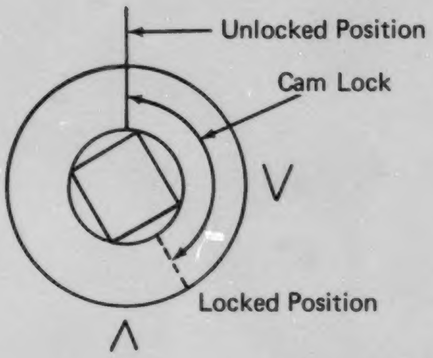
(NOTE: Large chucks have a threaded hole into which an eyebolt is screwed. A swing arm or overhead hoist is used to hold the weight of the chuck.)

JOB SHEET #1

C. Cam lock spindle

1. Place board under chuck
2. Disengage gear so that spindle turns freely
3. Insert square key into cam lock and turn to unlocked position (Figure 30)

FIGURE 30



4. Unlock all cam locks (three or six)
5. Tap top of chuck with soft-faced mallet to release chuck from tapered spindle

   (NOTE: Hold chuck with hand, pushing it toward headstock to prevent it from falling.)

6. Remove chuck with both hands

   (CAUTION: Keep your hands in a position where they are never between the chuck and board. If chuck is large or heavy, get help or use an overhead hoist or swing arm to carry the weight.)

III. Procedure for installing chuck

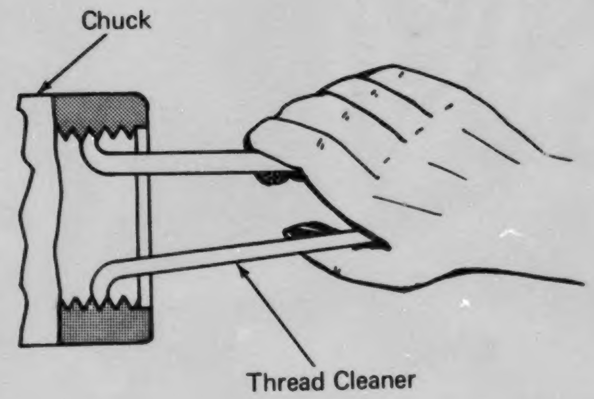
A. Threaded-nose spindle

1. Engage chuck in back gear or lock spindle; lay chuck on board

JOB SHEET #1

2. Clean chuck threads with wire thread cleaner (Figure 31)

FIGURE 31



3. Wipe with cloth to remove dirt and grit

4. Clean threads on lathe spindle with wire brush; wipe with cloth

5. Place a few drops of oil on lathe spindle threads

6. Screw chuck on spindle (clockwise rotation) by hand until it is snug

   (NOTE: Do not shoulder chuck with a quick jerk or snap; it will tighten itself as you work.)

B. Tapered-nose spindle

1. Engage lathe in back gear or lock spindle

2. Place board on ways

3. Clean spindle and lock ring threads with a cloth

4. Place chuck on the board, clean threads, and wipe out spindle

5. Place a few drops of oil on threads

6. Align key on spindle with key seat in chuck; slide chuck onto tapered nose

JOB SHEET #1

7. Turn locking ring counterclockwise (toward you) with one hand, while pushing chuck with other, until threaded ring has started on threaded portion of chuck

8. Finish tightening with spanner wrench; snug with mallet

C. Cam-lock spindle

1. Place board on ways

2. Set chuck on board

3. Clean locking pins and tapered portion of chuck

4. Clean tapered portion of lathe spindle and turn all cams to unlocked position, aligning indicators

5. Place a few drops of oil on locking pins

6. Put lathe spindle in neutral position

7. Turn spindle by hand until cam lock holes are in line with cam lock pins and seat chuck

8. Turn cam locks with wrench in clockwise direction indicated by arrows on chuck

9. Tap face of chuck with soft-faced mallet to seat taper

10. Finish tightening cam locks

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #2--PERFORM A FACING OPERATION

I. Equipment and materials

- A. Right-hand facing tool
- B. Lathe with chuck and tailstock center
- C. Steel rule, 6"
- D. Toolholder
- E. Wrenches for chuck and toolholder
- F. Steel bar, SAE 1018, 2 1/2" diameter, 4 1/4" long
- G. Cutting oil
- H. Quick-change tool post

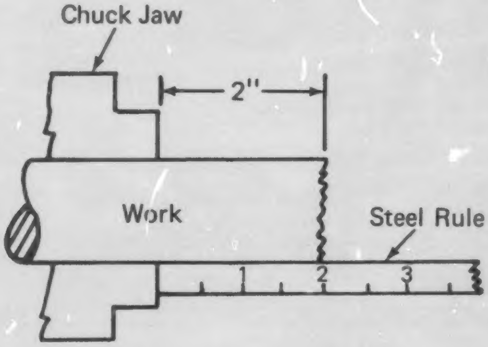
(NOTE: There are many types of tool posts and holders available. You may need to modify procedures slightly depending on the type used.)

II. Procedure

- A. Check oil levels and perform daily maintenance
- B. Chuck work with 2" protruding past end of jaw (Figure 32)

(NOTE: For a facing operation, the work should never extend out of the chuck more than three times its diameter unless supported.)

FIGURE 32

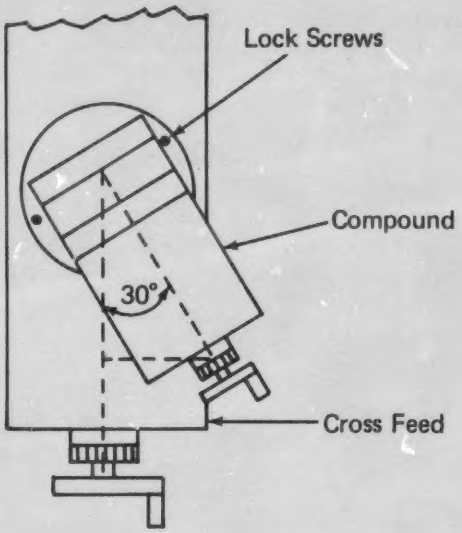


JOB SHEET #2

C. Loosen the compound rest locking screws and turn compound 30° to the right of cross feed; tighten locking screws (Figure 33)

(NOTE: The protractor base of the compound rest may or may not read 30°, depending on the zero mark location of the protractor.)

FIGURE 33

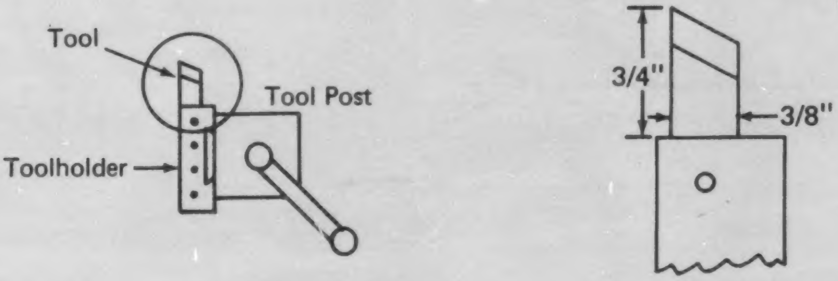

Lock Screws
Compound
30°
Cross Feed

D. Mount tool post on compound

E. Put tool in toolholder and mount on tool post (Figure 34)

(NOTE: The tool should never extend past the end of toolholder more than two times its width.)

FIGURE 34


Tool
Tool Post
Toolholder
3/4"
3/8"

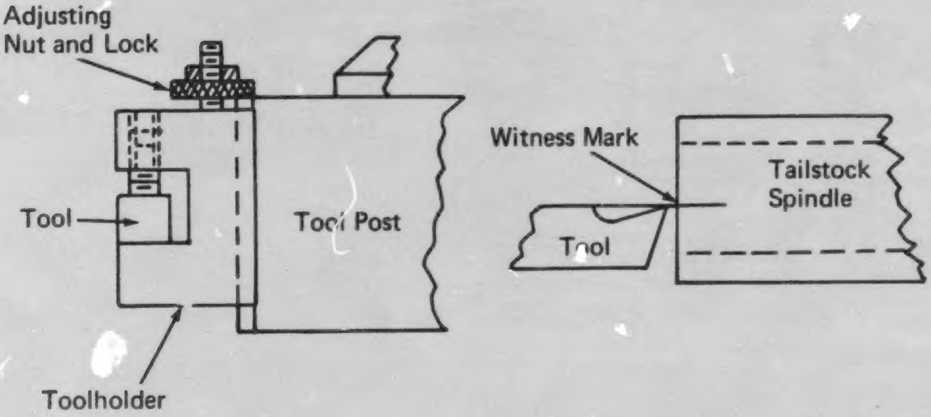
JOB SHEET #2

F. Adjust tool to center height, using one of the following methods

1. Adjust tool up or down with adjusting nut until point of tool is on witness mark on tailstock (Figure 35)

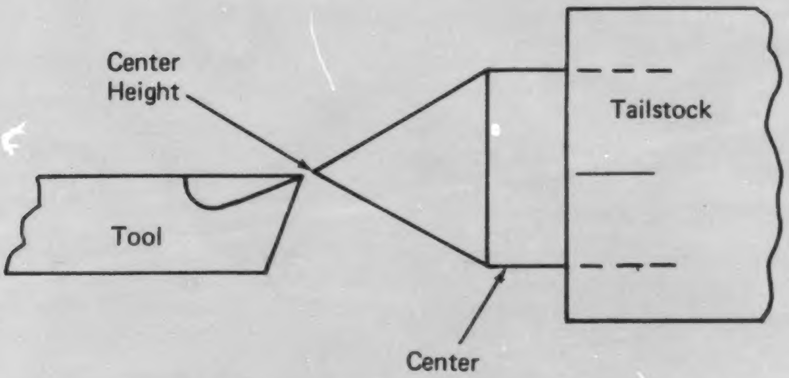
   (NOTE: When adjusting toolholder, the cam lock of the tool post must be loosened.)

FIGURE 35


Adjusting Nut and Lock
Tool
Tool Post
Toolholder
Witness Mark
Tailstock Spindle
Tool

2. Insert center in tailstock and set point of tool on point of center by adjusting as before (Figure 36)

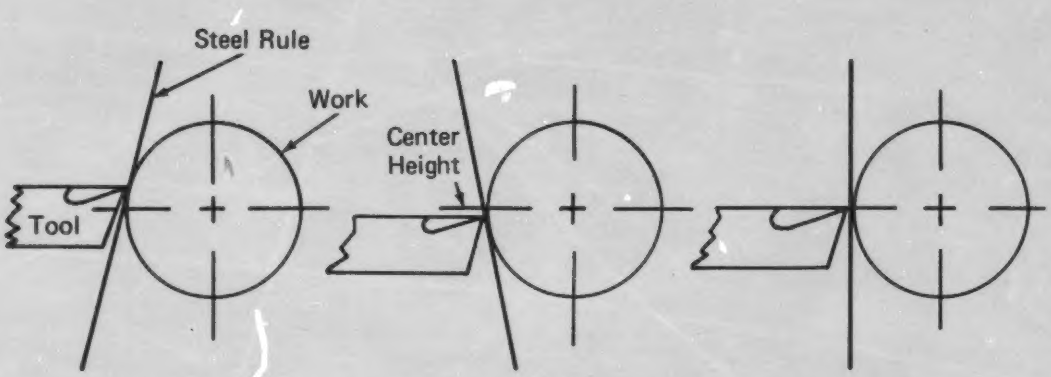
FIGURE 36


Center Height
Tailstock
Tool
Center

JOB SHEET #2

3. Place 6" steel rule between point of tool and work; advance tool with cross feed until it holds rule in place; adjust until rule is square to tool or until rule is straight up and down (Figure 37)

FIGURE 37



Tool Above Center Adjust

Tool Below Center Adjust

Tool on Center Lock Adjusting Nut

G. Set lathe at correct speed

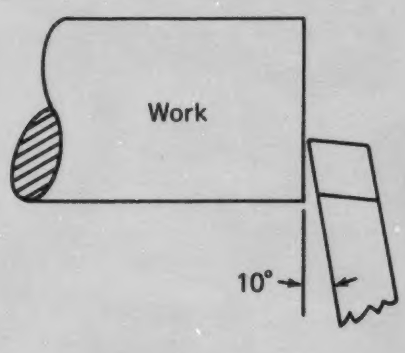
$$\frac{4 \times CS}{\text{Diameter (D)}} = \text{rpm} \qquad \frac{4 \times 120}{2.5} = 192 \text{ rpm}$$

(NOTE: Lathe speeds used in this unit are based on the charts following Information Sheet in Unit II. However, different speeds may be required depending on your equipment, experience, or other factors. The cutting speed for facing is the same as that used for turning.)

JOB SHEET #2

H. Set tool so that cutting edge has about 10° clearance between end of work and tool (Figure 38)

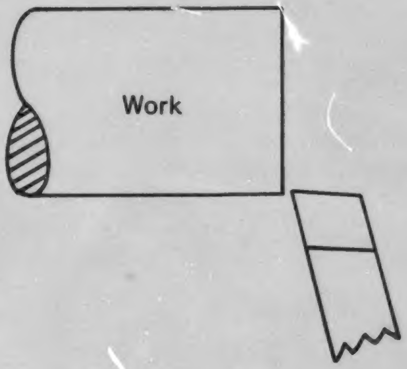
FIGURE 38



I. Check setup to make sure chuck, work, tool post and holder, tool, and compound are tight; snug carriage lock bolt to prevent carriage from moving

J. Position tool near outer edge of work (Figure 39)

FIGURE 39

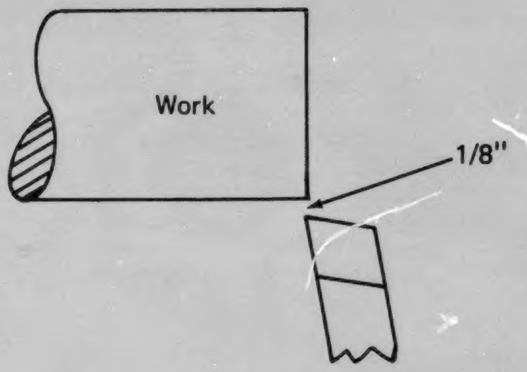


K. Turn on lathe, start spindle, and advance tool with compound until it starts to cut

JOB SHEET #2

L. Crank the tool away from work with cross feed until tool clears work 1/8" (Figure 40)

FIGURE 40



M. Advance compound to cut end of work 0.020"; apply cutting oil as required during cutting

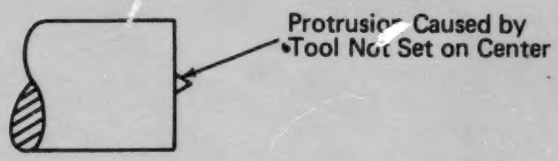
(NOTE: This movement would be 0.040" if the graduated collar reads 1 to 1 [for each thousandth of an inch of feed on the collar, the tool moves the same amount]; this type of graduation is also called an *indirect-reading dial* or a *single depth reading dial.* The reason the cut is only half the amount of feed is because the compound is set on 30° and the sine of 30° is 0.5.)

N. Crank cross feed handwheel slowly with a continuous motion until tool reaches center; crank tool back 1/8" from edge of work and stop spindle

O. Inspect work

1. If all of saw cut has not been removed, advance compound feed 0.020" and repeat facing procedure
2. If a protrusion is left in the center, the tool height is incorrect; adjust tool height and repeat facing procedure (Figure 41)

FIGURE 41

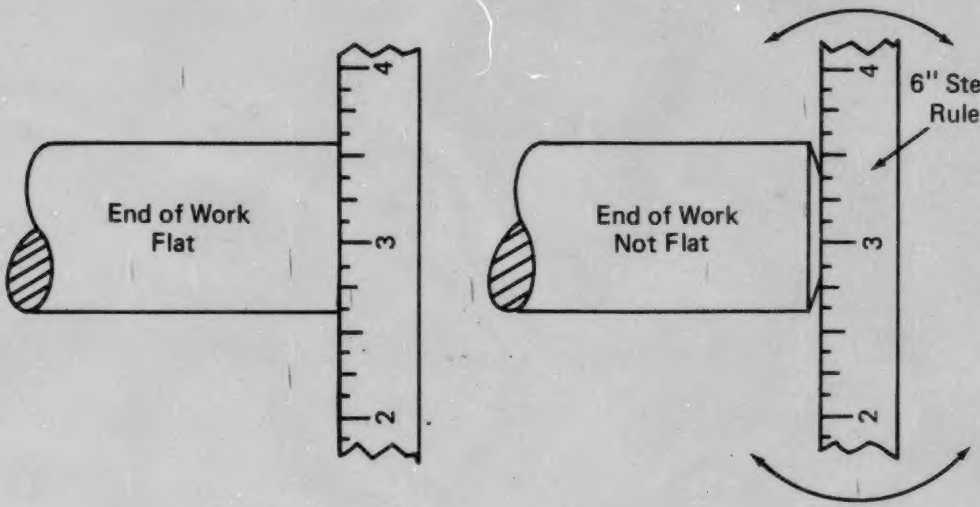


3. Inspect work and repeat steps J to O as necessary until the end is smooth

JOB SHEET #2

P. Stop spindle when end is smooth; check end for flatness with 6" rule (Figure 42)

FIGURE 42


4
3
2
End of Work
Flat
6" Steel
Rule
End of Work
Not Flat

(NOTE: If end is flat, continue to step R.)

Q. If steel rule rocks, tighten tool or carriage and take another cut

(NOTE: The end of the work may also be rounded due to pressure pulling the carriage or compound.)

R. If time permits, continue with next job sheet; if not, clean machine, put away all tools, and put part in locker

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #3--FACE A PART TO LENGTH

I. Equipment and materials

- A. Right-hand facing tool
- B. Lathe with chuck and tailstock center
- C. Steel rule, 6"
- D. Vernier calipers, 6"; or micrometer
- E. Wrenches for chuck, tool post, and compound
- F. Quick-change toolholder with wrenches
- G. Cutting oil
- H. Steel bar, SAE 1018, 2 1/2" diameter, 4 1/4" long

  (NOTE: This is the same part used in Job Sheet #2.)
- I. File

II. Procedure

- A. Check oil levels and perform daily maintenance
- B. Place previously faced part into chuck until about 2" protrudes from chuck jaws
- C. Set compound 30° to right of cross feed
- D. Mount tool post on compound
- E. Put tool in toolholder
- F. Adjust tool to center height
- G. Set rpm at 192
- H. Set tool so that cutting edge has about 10° clearance
- I. Check setup to make sure chuck, work, tool, tool post, and compound are tight
- J. Position tool near outer edge of work
- K. Turn on spindle, and advance the tool with compound until it just starts to cut end of work

JOB SHEET #3

L. Crank tool away from work with cross feed until tool is clear of work

M. Advance compound 0.040" and crank cross feed in to center; apply cutting oil as required during cutting; then, crank cross feed back out until it is clear of work

N. Stop spindle and examine end; if cut is not smooth and flat, make adjustments and take another cut by advancing compound 0.040"

O. Remove part from chuck; measure length of part with vernier calipers or micrometer

P. Subtract 4.000" from measurement to determine amount of material to be removed from end

EXAMPLE:
4.180" Length measured
- 4.000" Length desired
0.180" Amount to be removed

Q. Determine amount to remove each time a cut is made

EXAMPLE:
0.180" Amount to remove
0.030" One finish cut of 0.030"
0.150" Rough cut amount to remove

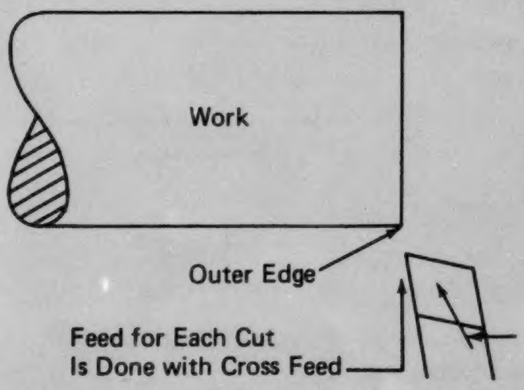
Three rough cuts at 0.050" = 0.150"

R. Put work back in chuck with 2" protrusion; tighten chuck jaws

S. Position tool near end of work and start spindle

T. Advance compound slowly until it just starts to cut end of work; use cross feed and crank tool past outer edge of work (Figure 43)

FIGURE 43



JOB SHEET #3

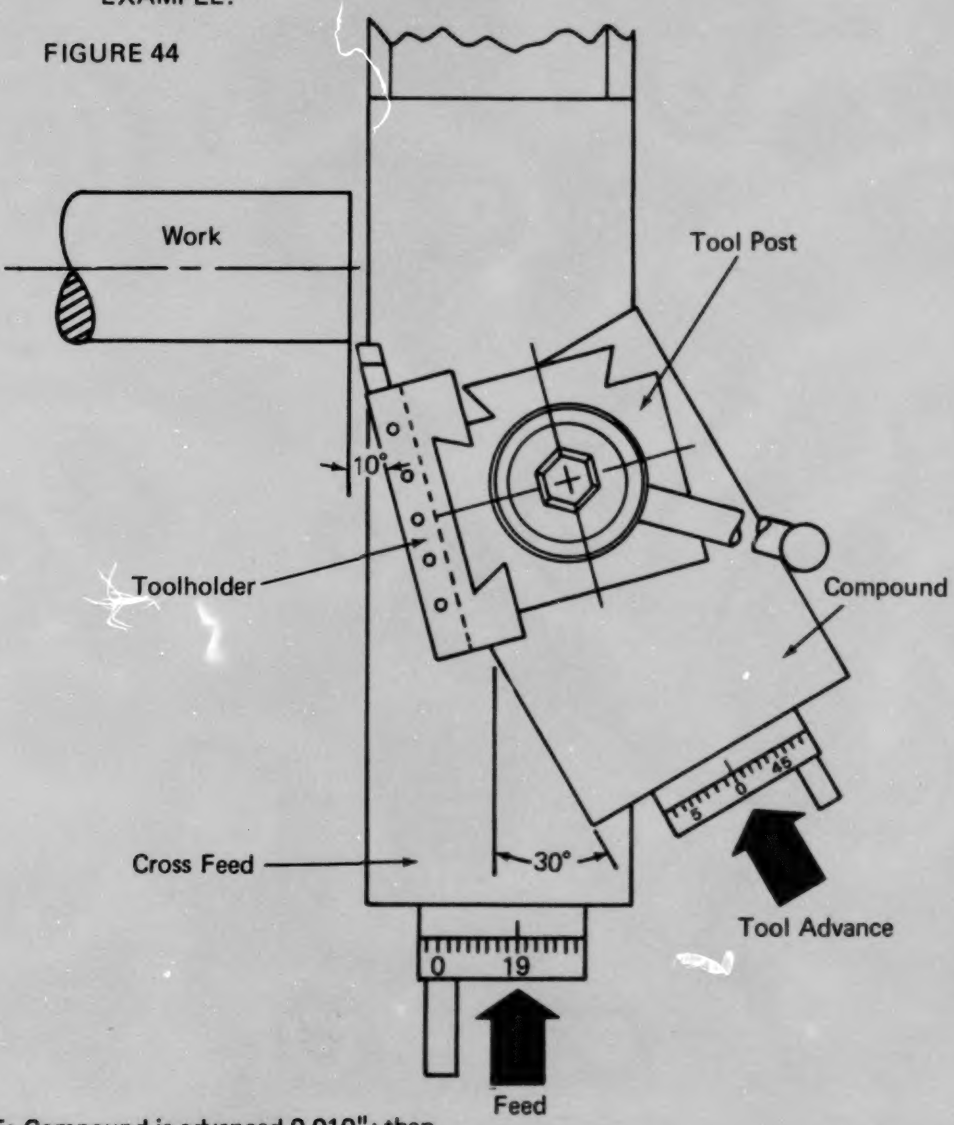
U. Zero graduated collar of compound

V. Snug carriage lock, and advance compound for first rough cut (Figure 44)

(NOTE: Because the compound is set on 30° and the sine of 30° is 0.5 [1/2], it takes 0.002" feed of the compound to cut 0.001" off the end, provided the ratio of compound is 1:1.)

EXAMPLE:

FIGURE 44

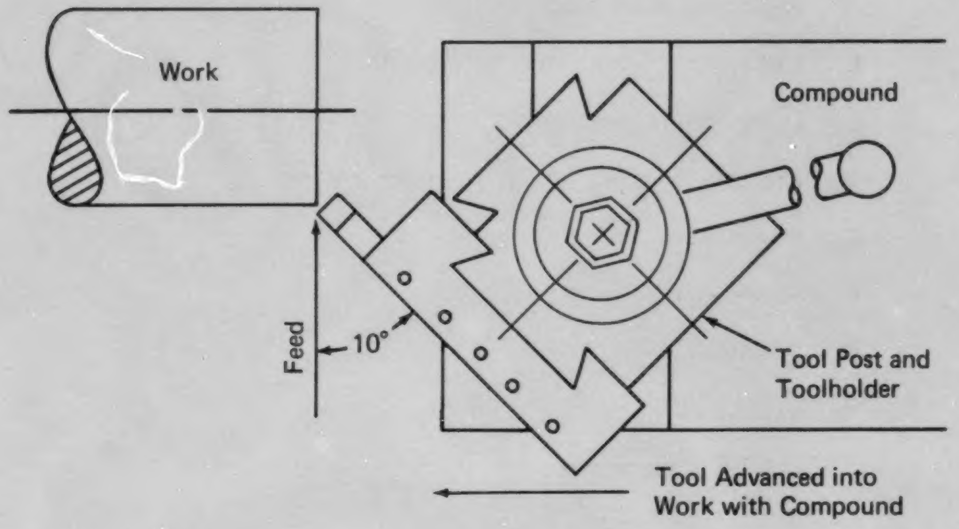

Work
Tool Post
10°
Toolholder
Compound
5
0
45
Cross Feed
30°
Tool Advance
0
19
Feed

(NOTE: Compound is advanced 0.010"; then 0.005" is removed from end of work.)

JOB SHEET #3

W. Apply cutting oil as required, and continue taking cuts to remove required amount in rough cutting (Figure 45)

FIGURE 45


Work
Compound
Feed
10°
Tool Post and Toolholder
Tool Advanced into Work with Compound

X. Increase rpm and make finish cut

Y. Remove sharp edges from work by filing slightly at angle on both ends

Z. Remove part from chuck, check length, and turn part in to instructor

(NOTE: If part is not 4.000" ± 0.001", chuck and recut.)

AA. Clean machine and put all tools in proper places

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #4--PERFORM A STRAIGHT TURNING OPERATION

I. Equipment and materials

A. Right-hand turning tool

B. Lathe with chuck and tailstock center

C. Quick-change toolholder

D. Wrenches for chuck, tool post, and toolholder

E. Steel rule, 6"

F. Micrometer, 2" to 3"

G. Cutting oil

H. Steel bar, SAE 1018, 2 1/2" diameter, 4" long

(NOTE: There are many types of tool posts and toolholders. You may need to modify procedures slightly to fit your type.)

II. Procedure

A. Check oil levels and perform daily maintenance

B. Set compound rest 30° to right of cross feed and secure in place

C. Mount tool post on compound

D. Put cutting tool in toolholder and mount on tool post

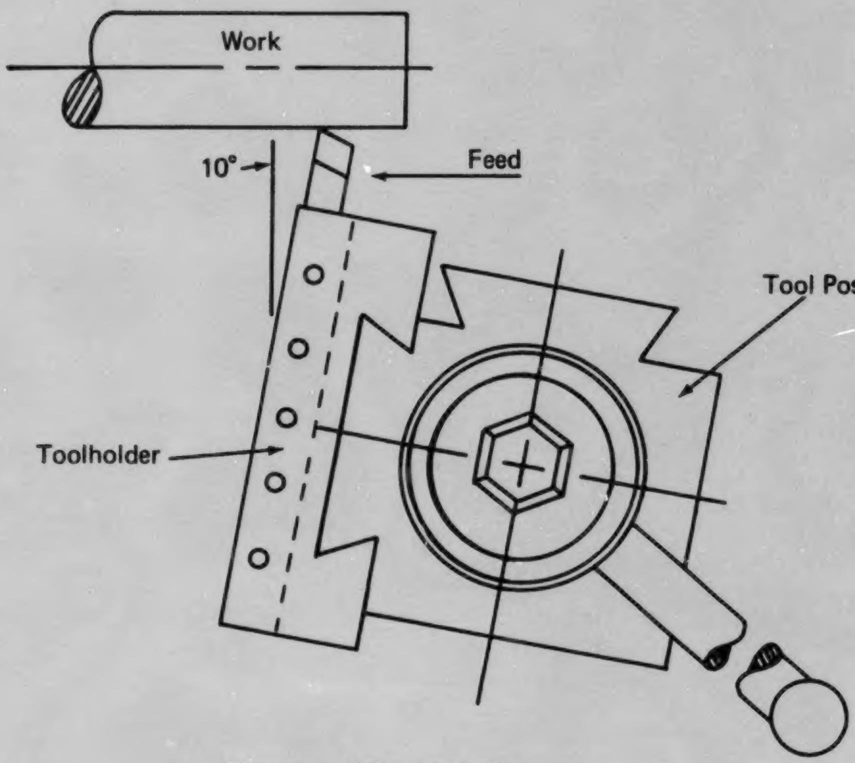
E. Adjust tool to center height

F. Mount work in chuck with 3.0" protruding from end of chuck jaws

JOB SHEET #4

G. Position tool post so that cutting edge of tool is approximately 10° away from feed direction (Figure 46)

FIGURE 46


Work
10°
Feed
Tool Post
Toolholder

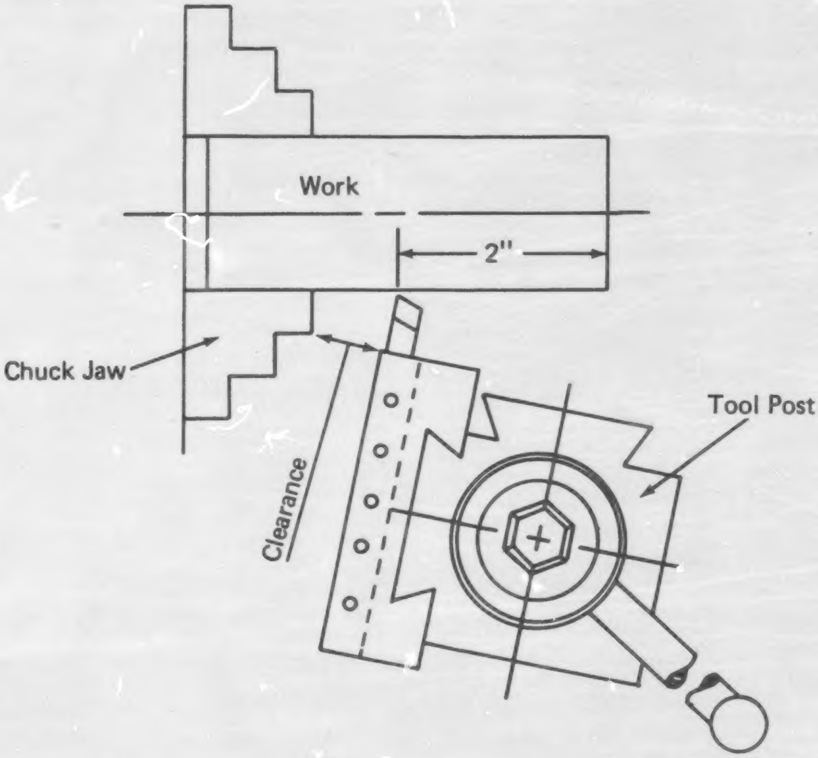
Direction of Feed Is Left
Toward the Headstock

JOB SHEET #4

H. Check to see that tool is positioned to allow it to move 2.0" from end of work without tool or toolholder contacting the chuck or chuck jaws (Figure 47)

(CAUTION: When performing this check, the spindle should not be rotating.)

FIGURE 47

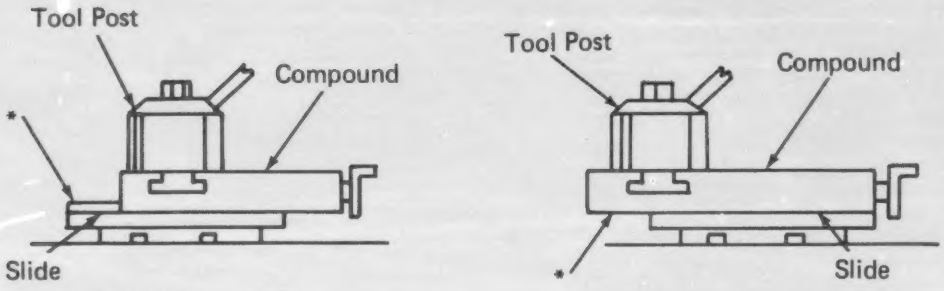

Work
2"
Chuck Jaw
Tool Post
Clearance

I. Readjust toolholder if necessary

JOB SHEET #4

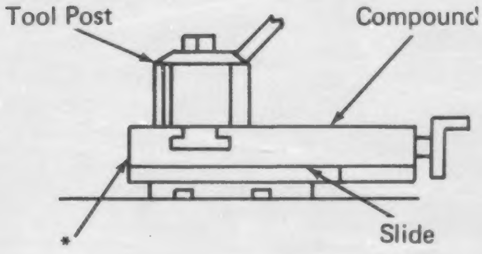
J. Make sure that end of compound is at end of slide; this will prevent damage to slide and provide maximum support for compound (Figure 48)

FIGURE 48


Tool Post
Compound
*
Slide
Tool Post
Compound
*
Slide

* Possible Damage to Slide When Turning

* Possible Damage to Compound When Turning


Tool Post
Compound
*
Slide

* Compound and Slide in Proper Relation to Each Other When Turning

K. Set rpm for roughing at 192 rpm

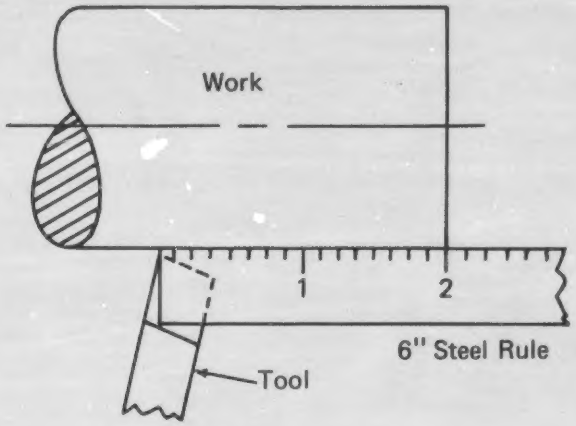
L. Set lathe feed at 0.015 ipr

(NOTE: The speed [sfpm] and the feed [ipr] were obtained using the charts following Information Sheet in Unit II.)

JOB SHEET #4

M. Crank cross feed back until tool is clear; move carriage to position tool about 2.0" from end of work; then use steel rule to position (Figure 49)

FIGURE 49

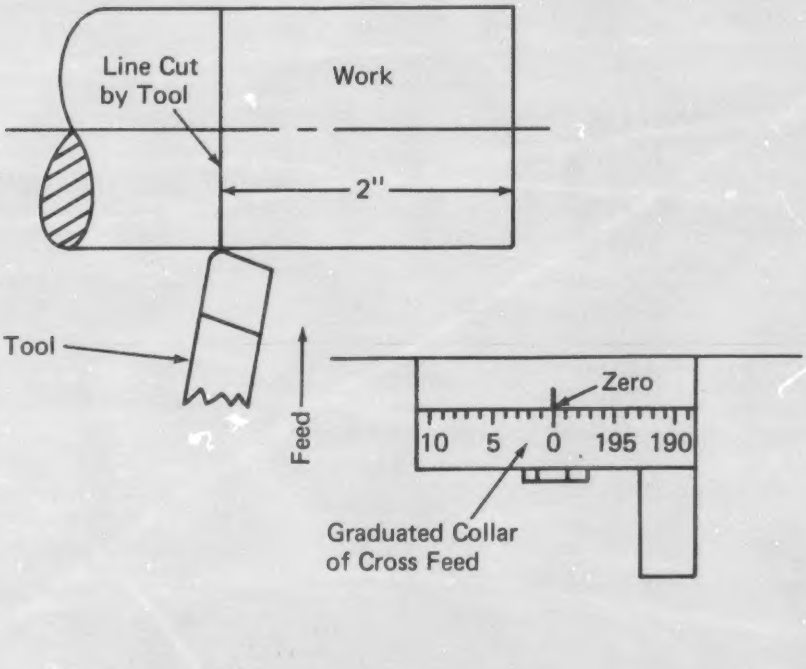

Work
1
2
6" Steel Rule
Tool

N. Turn on power and start spindle rotating

O. Advance cross feed slowly by hand until tool just shaves work; stop spindle and zero cross feed dial (Figure 50)

(NOTE: Do not move cross feed until the graduated collar has been set, as the backlash is eliminated in the direction of feed.)

FIGURE 50


Line Cut by Tool
Work
2"
Tool
Feed
Zero
10
5
0
195
190
Graduated Collar of Cross Feed

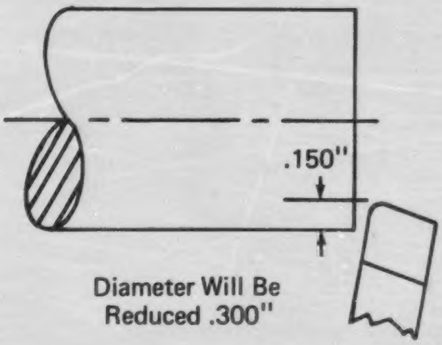
JOB SHEET #4

P. Crank cross feed counterclockwise until tool clears work; then crank carriage to the right until tool is 1/4" past end of work

Q. Start spindle and advance tool so that depth of cut is 0.150" (Figure 51)

(NOTE: If graduated collar is graduated on radius, advance the reading to 0.150"; if graduations read on diameter, advance the dial 0.300".)

FIGURE 51



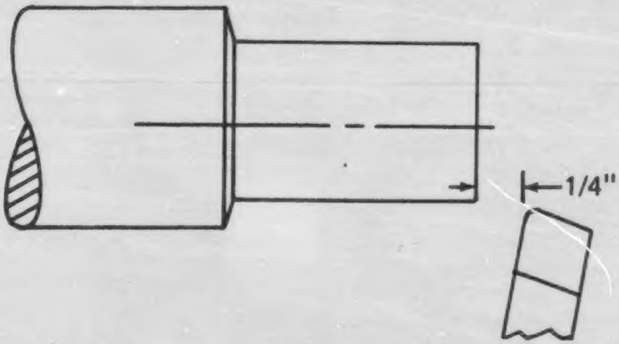
R. Apply cutting oil as required during cutting; engage longitudinal feed and allow tool to move by power to within 1/64" of 2" line; disengage power feed and feed tool manually to line

(NOTE: If the speed and feed are correct, the chips should roll and break, and the color of the chips should NOT turn blue or dark brown until they are about 1/8" from the cutting edge of tool. When the chips turn color as they are being cut, the heat is transferred to the tool; and the tool will not hold up.)

S. Move tool by hand so that tool is 1/4" from end of work; and stop spindle (Figure 52)

(NOTE: Do not move the cross feed graduated dial from its setting.)

FIGURE 52



JOB SHEET #4

T. Measure diameter; subtract 2.050" from diameter to determine amount left to be removed by rough cutting

U. Start spindle; advance tool for second rough cut and repeat step R

V. Move tool 1/4" from end, stop spindle, and measure diameter of work; subtract 2.000" to determine amount of finish cut

(NOTE: The specified finished diameter is 2.000" ± 0.001".)

(CAUTION: Never measure work that is turning.)

W. Increase rpm to 320 for finish cut

X. Set feed at 0.007 ipr

Y. Start spindle; advance tool for finish cut

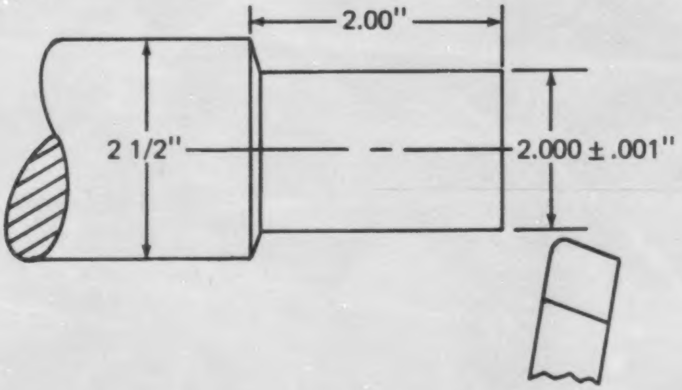
Z. Engage power feed and allow tool to cut 1/8"; then stop spindle and check diameter

1. If diameter is still too large, move tool to end of work and advance tool the amount needed
2. If work is too small, observe dial setting, back tool away from work, and then feed tool back in, less the amount the work was too small

EXAMPLE: Part measures 1.994", which is 0.006" too small; dial reading is 150; turn dial back to 120 to remove backlash, and then up to 144.

AA. Start spindle and cut part to size, using the same technique as before (Figure 53)

FIGURE 53



(NOTE: The shoulder will be squared in Job Sheet #5.)

JOB SHEET #4

BB. Stop machine, remove part from chuck, clean machine, and put all tools away

CC. Turn in part to instructor for evaluation

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #5--TURN A PART WITH SQUARE SHOULDER TO LENGTH

I. Equipment and materials

A. Right-hand turning tool

B. Right-hand shouldering tool

C. Lathe with chuck and tailstock center

D. Quick-change tool post and toolholder

E. Wrenches for chuck, tool post, and toolholder

F. Steel rule, 6"

G. Micrometer, 1" to 2"

H. Depth micrometer with 2" to 3" extension

I. Micrometer carriage stop

J. Cutting oil

K. Steel bar, SAE 1018, 2 1/2" diameter, 4" long

(NOTE: This material was used in Job Sheet #4.)

L. Pencil or chalk

II. Procedure

A. Check oil levels and perform daily maintenance

B. Set compound rest 30° to right of cross feed and secure in place

C. Mount tool post on compound

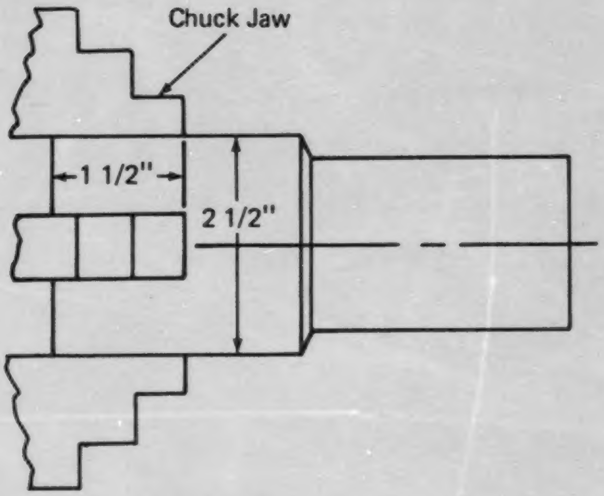
D. Put right-hand turning tool in toolholder and mount on tool post

E. Adjust tool to center height

JOB SHEET #5

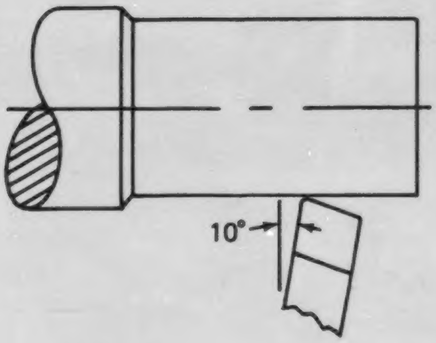
F. Chuck unmachined end of work with about 1 1/2" in chuck jaws (Figure 54)

FIGURE 54



G. Position tool by turning tool post so that cutting edge of tool is approximately 10° off in direction of feed (Figure 55)

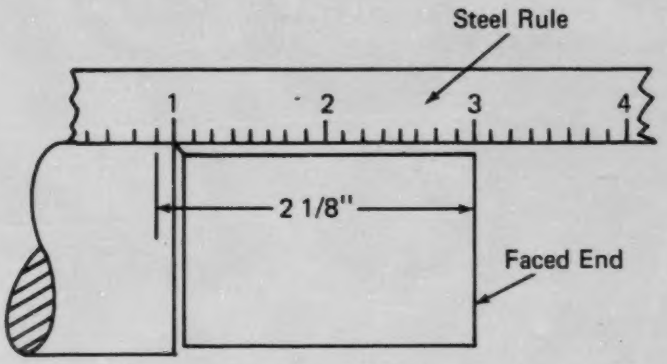
FIGURE 55



JOB SHEET #5

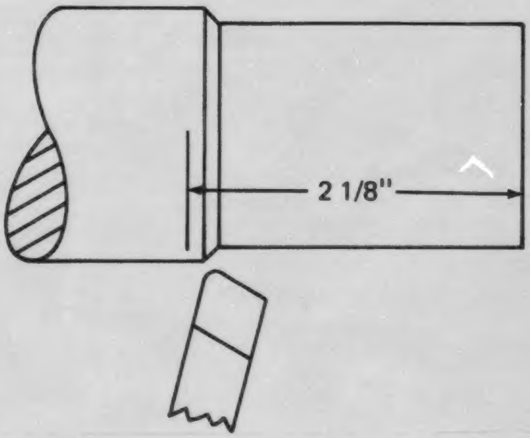
H. Make a mark on work 2 1/8" from faced end (Figure 56)

FIGURE 56


Steel Rule
1
2
3
4
2 1/8"
Faced End

I. Position tool by moving carriage so that point of tool is at shoulder (Figure 57)

FIGURE 57

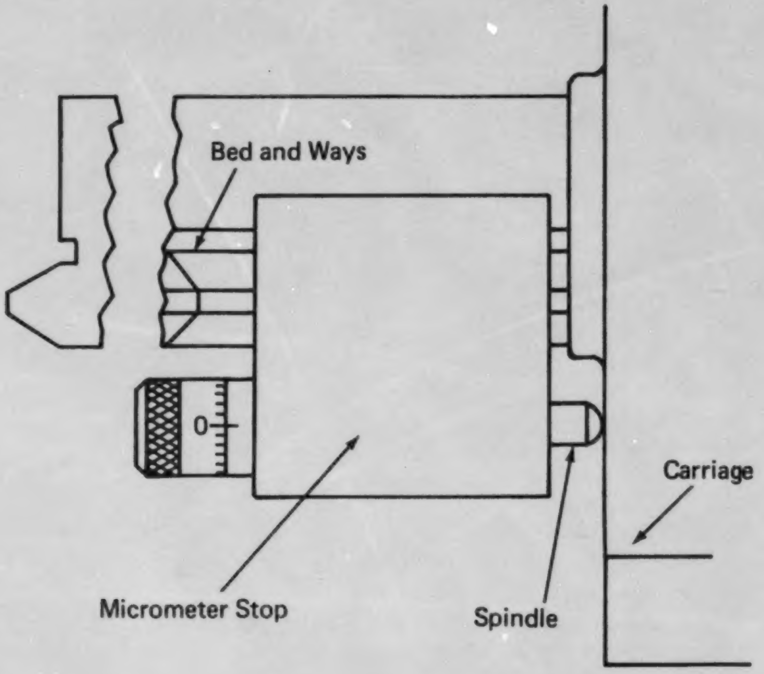


JOB SHEET #5

J. Move micrometer carriage stop up until spindle makes contact with carriage; lock stop in place with lock screws

(NOTE: The spindle of the micrometer carriage stop should be in the middle of the in-and-out travel; see Figure 58. Dial indicators, travel dials, or way indicators are sometimes used in place of carriage stops.)

FIGURE 58



K. Move tool to end of work, and start spindle rotating; advance tool with cross feed until it just starts to shave the previously machined area and zero graduated collar of cross feed; stop spindle

L. Set spindle speed at 240 rpm; set feed rate at 0.015 ipr for rough turning

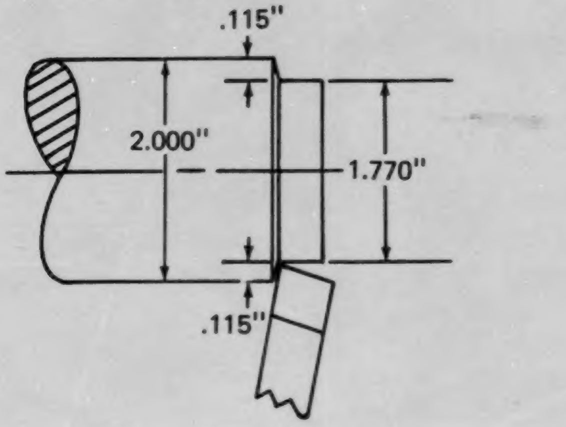
M. Move tool away from end about 1/8"; advance tool 0.115"; start spindle

JOB SHEET #5

N. Engage power feed and allow tool to cut until it reaches end of previous cut; disengage power feed; apply cutting oil as required during cutting

(NOTE: Tool is advanced 0.115", making the amount of material removed 0.230"; see Figure 59.)

FIGURE 59



O. Finish feeding tool by turning handwheel until carriage makes contact with carriage stop

(CAUTION: Do not let the tool remove the 2 1/8" line. You may need to stop short of making contact with the carriage because, due to the angle of the cutting edge, the more the tool is fed in to reduce the diameter, the longer the cut will become.)

P. Make another cut of 0.115"; move tool clear of end of work and stop spindle

(NOTE: Do not move cross feed.)

Q. Change speed to 320 rpm for finish cut; set feed rate at 0.007 ipr

R. Measure diameter of work and subtract 1.500", which is diameter desired

EXAMPLE:	1.540"	Measured diameter
	-1.500"	Desired diameter
	0.040"	Amount of material to be removed

S. Start spindle and advance tool to make finish cut; engage power feed and allow tool to cut about 1/4"; disengage power feed and stop spindle

JOB SHEET #5

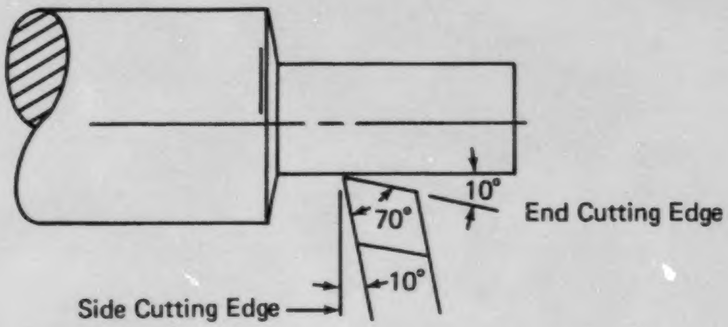
T. Check diameter with micrometer; make adjustments if the work is too large; apply cutting oil as required and turn to shoulder

(NOTE: The reading should be 1.500" ± 0.001".)

U. Change tool in toolholder to shouldering or facing tool, set on center height, and loosen tool post so that cutting edge of tool can be set to turn to length with square shoulder

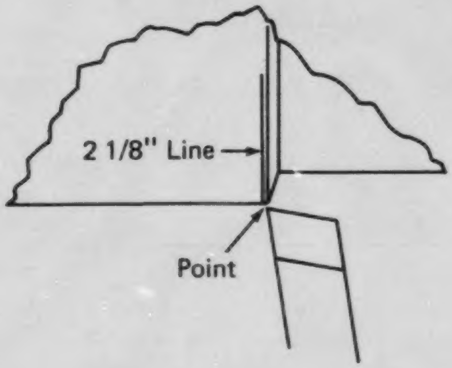
(NOTE: The side and end cutting edges should have the same clearance to produce a square shoulder. See Figure 60.)

FIGURE 60



V. Position tool so that point is even with outer edge of shoulder; reset carriage stop (Figure 61)

FIGURE 61

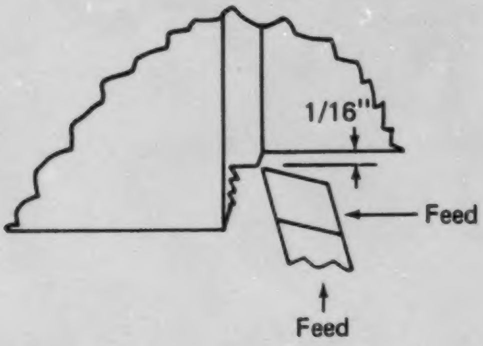


W. Move tool clear, advance tool about 0.050", and turn carriage handwheel until carriage reaches carriage stop

JOB SHEET #5

X. Continue to make cuts, slowly advancing tool until point of tool is about 1/16" from finished diameter (Figure 62)

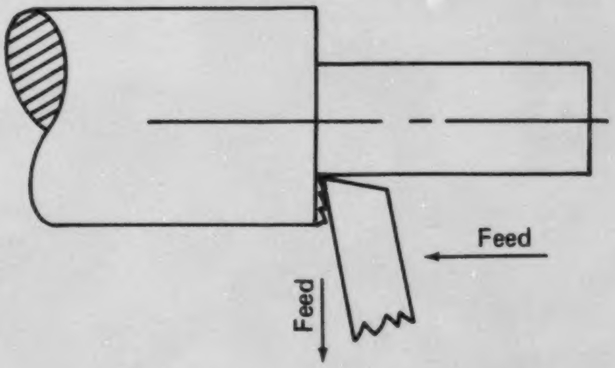
FIGURE 62



Y. Move micrometer adjustment of carriage stop to allow carriage to move 0.003" closer to 2 1/8" line

Z. Advance tool until it is about 1/64" from finished diameter and feed tool to carriage stop; keep pressure on handwheel with left hand and crank cross feed by hand counterclockwise with a slow, continuous movement as you face the shoulder square (Figure 63)

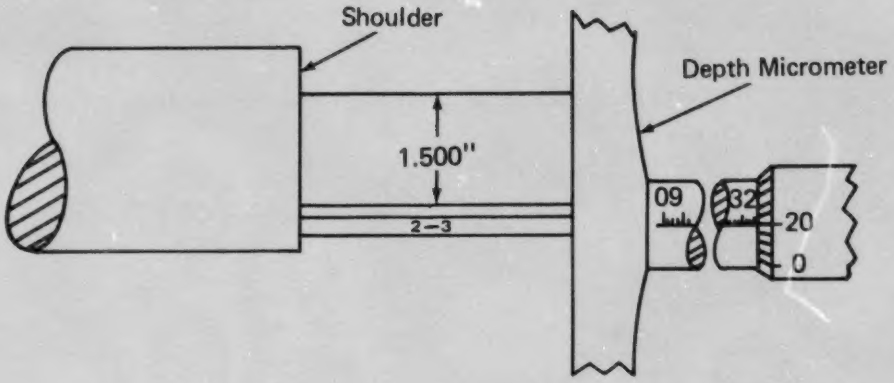
FIGURE 63



JOB SHEET #5

AA. Stop spindle; use depth micrometer to measure turned length from end to shoulder (Figure 64)

FIGURE 64


Shoulder
Depth Micrometer
1.500"
2—3
09
32
20
0

BB. Subtract measured length from 2.125" to determine how much more is required to be cut off shoulder (Figure 65)

EXAMPLE:		
	2.125"	Length desired
	-2.120"	Length measured
	0.005"	Remaining to be cut

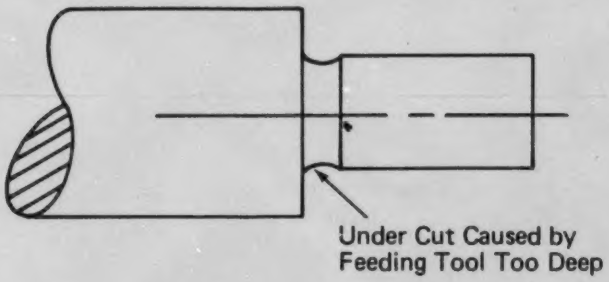
(NOTE: If remaining amount to be faced off is greater than 0.005", you will need to make more than one cut.)

CC. Turn micrometer screw of carriage stop the required amount

DD. Start spindle, advance tool until it just shaves the diameter, move carriage to carriage stop, and feed tool out, facing the shoulder

(CAUTION: When feeding tool in, be careful not to cut below desired diameter. See Figure 65.)

FIGURE 65


Under Cut Caused by
Feeding Tool Too Deep

JOB SHEET #5

EE. Stop spindle and remeasure length

(NOTE: Length should be 2.125" ± .002".)

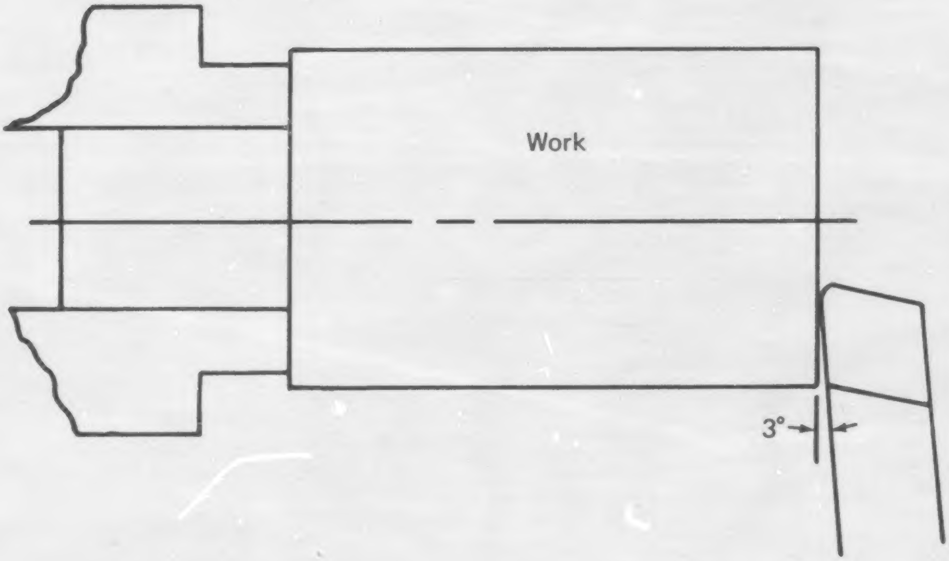
FF. Remove part from chuck, turn end-for-end and rechuck on diameter just machined

(NOTE: Normally, it is not recommended to chuck on finished work unless a collet chuck or a chuck with soft jaws is being used; it is done here only as a learning exercise.)

GG. Remove facing or shouldering tool; put turning tool in toolholder and set on center height

HH. Loosen tool post and position tool so that cutting edge has about 3° clearance from end of work (Figure 66)

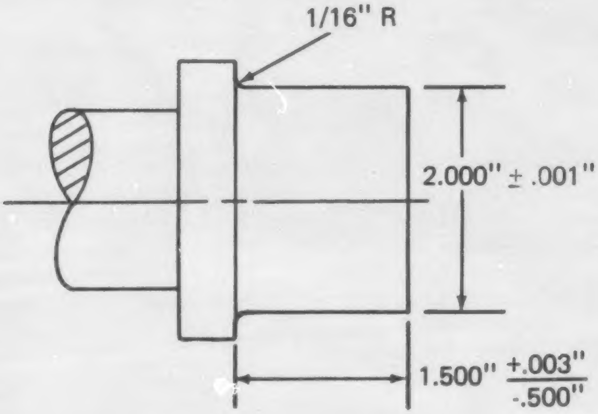
FIGURE 66



JOB SHEET #5

II. Use tool to turn diameter to 2.000", 1 1/2" in length; face shoulder square leaving a fillet (Figure 67)

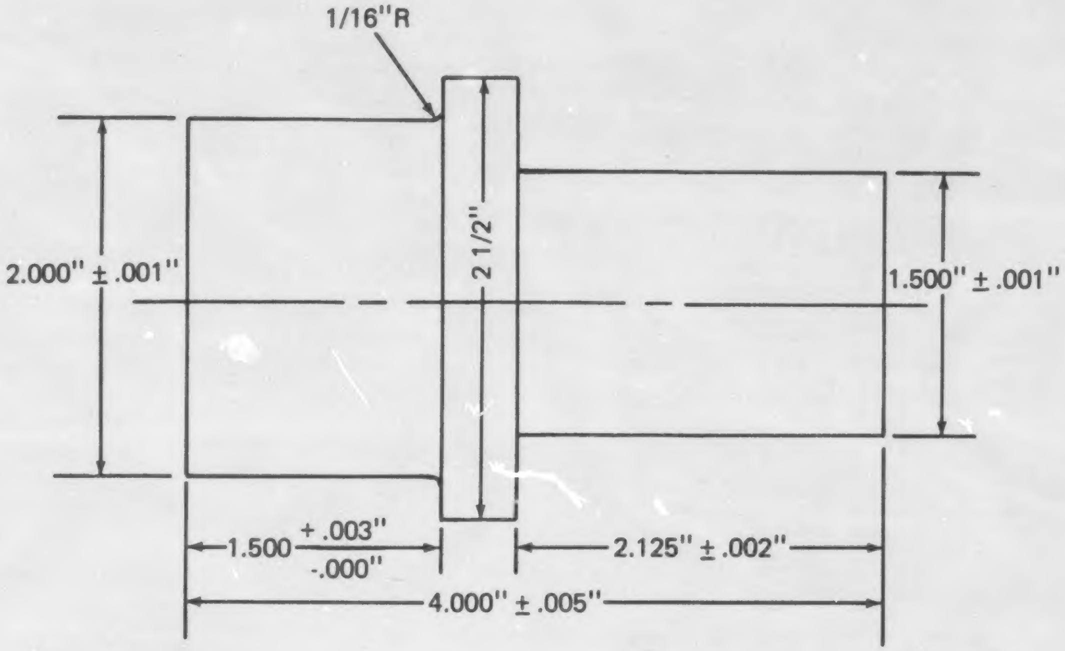
FIGURE 67



JJ. Clean machine, put away all tools, complete evaluation sheet on following page, and turn in work to instructor

JOB SHEET #5--EVALUATION SHEET

NAME________________________________ SCORE ________________


1/16"R
2.000" ± .001"
2 1/2"
1.500" ± .001"
1.500 + .003" -.000"
2.125" ± .002"
4.000" ± .005"

Dimensions	In Tolerance	Out of Tolerance
2.000" dia. ± 0.001"		
1.500" length + 0.003" - 0.000"		
1.500" dia. ± 0.001"		
2.125" length ± 0.002"		
4.000" length ± 0.005"		

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #6--USE DIAL INDICATOR TO ALIGN WORK IN FOUR-JAW CHUCK

I. Equipment and materials

A. Plunger-type dial indicator

B. Magnet-base indicator holder

C. Lathe with four-jaw chuck

D. Steel rule, 6"

E. Wrenches for chuck

F. Steel bar, SAE 1018, 2 1/2" diameter, 4" long

(NOTE: This is the same material used for Job Sheets #2-#5. This [illegible] indicated so that part turns true when chamfering.)

G. Pencil

II. Procedure

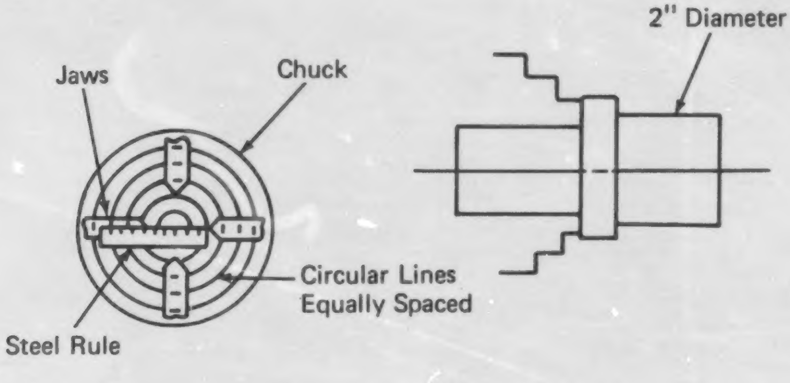
A. Mount four-jaw chuck if not already on machine

B. Put lathe in neutral or release belt tension so that chuck can be turned by hand

C. Open jaws of chuck to approximately 1 1/2" diameter and insert round steel part (Figure 68)

(NOTE: Use steel rule and circular lines on face of chuck when opening jaws.)

FIGURE 68



D. Snug jaws down on part by tightening them at 90° angles to each other, just enough to hold part secure

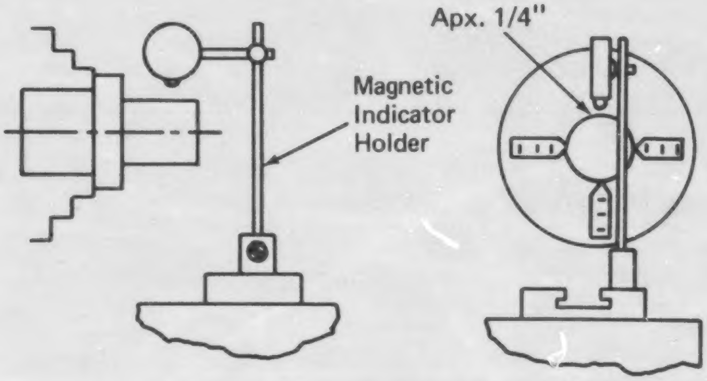
JOB SHEET #6

E. Mount indicator to magnetic base

F. Put magnetic base on cross slide or compound with dial facing you; check to see that magnet is secure

G. Move carriage toward headstock until indicator is approximately 1/4" above (Figure 69)

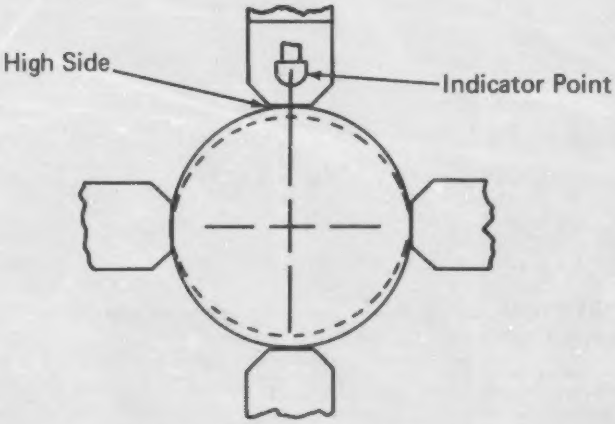
FIGURE 69


Apx. 1/4"
Magnetic Indicator Holder

H. Grasp pencil in right hand, steady your arm on toolholder or bed of machine, start rotating chuck with left hand, and slowly move pencil toward part until you make a mark (Figure 70)

(NOTE: The mark is at what is referred to as *high point.*)

FIGURE 70


High Side
Indicator Point

JOB SHEET #6

I. Loosen jaw opposite high side and tighten high side just a little; then retighten adjusting screw on low side

(NOTE: Always work with opposite jaws.)

J. Wipe off pencil mark and turn part while holding pencil close to work; keep turning and move pencil forward slowly to find new high point

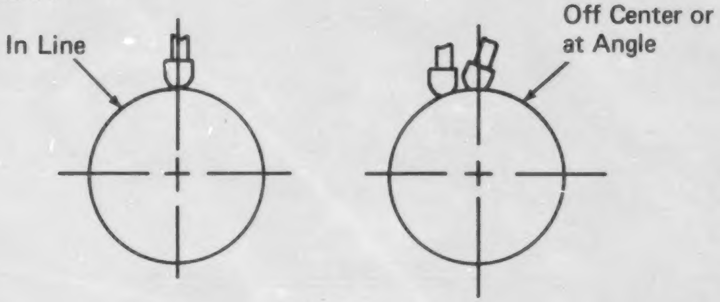
K. Loosen screw on low side and tighten new high side

L. Check with pencil again; if pencil marks work approximately three-fourths of way around circumference, you are ready to use indicator; if not, continue to adjust until mark is made on approximately three-fourths of circumference

M. Move indicator down until point is touching work; turn cross feed handwheel, moving indicator back and forth over work; when indicator needle is at its maximum reading, stop and adjust dial to read zero (Figure 71)

(NOTE: The straighter the indicator plunger is to the work, the less error you will have.)

FIGURE 71



N. Rotate work and note the difference; loosen screw on low side and tighten high side, shifting part approximately half the difference

O. Continue this process until the needle of the indicator shows no movement

(NOTE: When there is only 0.003" or 0.004" difference, you can usually just tighten the high side half the difference.)

(CAUTION: Work with opposite jaws. Never loosen adjoining jaws, or the part will fall out.)

P. When work is true, have instructor check alignment

Q. Clean machine and put all tools in proper places

(NOTE: If this job sheet took you more than five minutes, you should practice procedures more.)

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #7--PERFORM CHAMFER OPERATIONS

I. Equipment and materials

- A. Square-nosed tool bit
- B. File with handle
- C. Steel rule, 6"
- D. Lathe with four-jaw chuck and tailstock center
- E. Quick-change tool post and toolholders
- F. Wrenches for chuck, tool post and holder, and compound
- G. Dial indicator with magnetic base
- H. Steel bar, SAE 1018, 2 1/2" diameter, 4" long

  (NOTE: This is the same material used for facing and turning operations.)

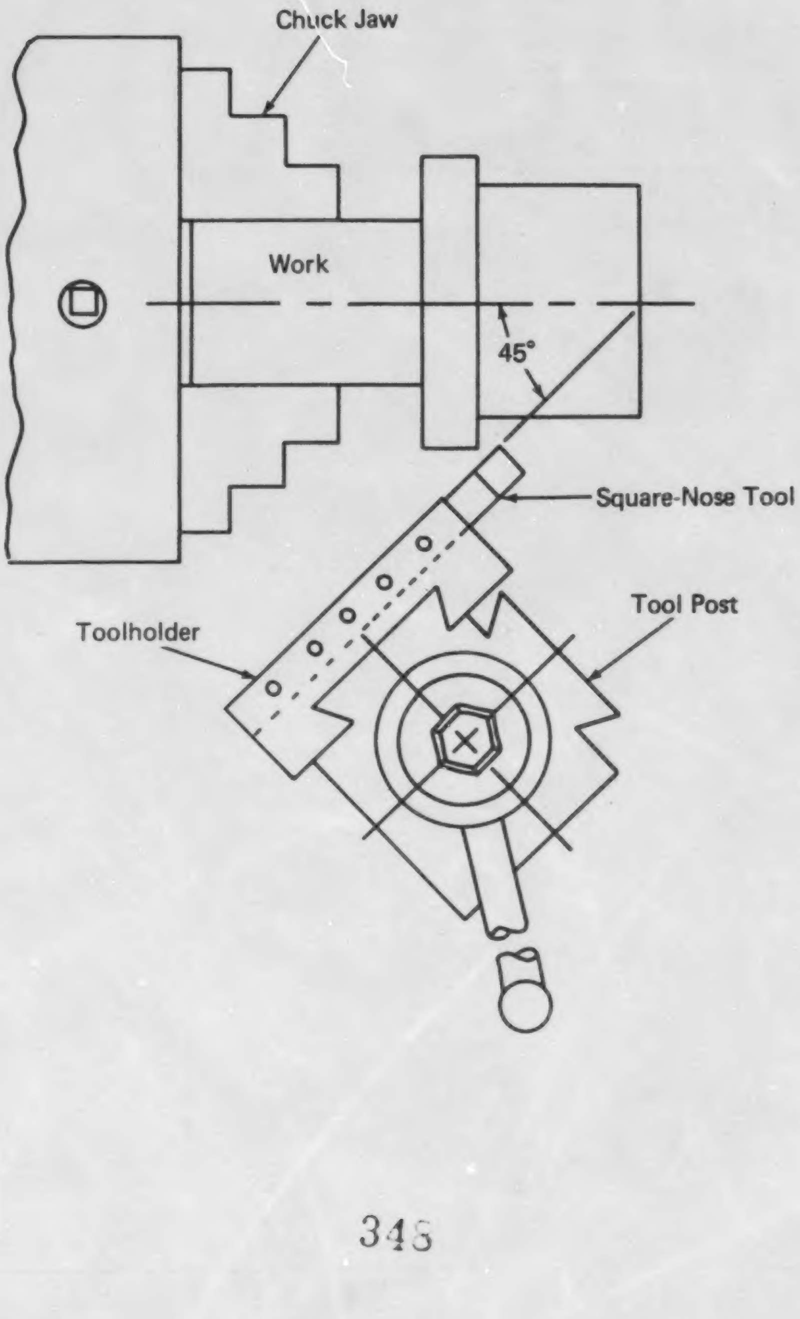
II. Procedure

- A. Form a chamfer
  1. Check oil levels and perform daily maintenance
  2. Align work in chuck with 2" diameter protruding from chuck
  3. Mount square-nosed tool in toolholder and set tool to center height
  4. Form chamfer with side of tool
     a. Set compound 45° to right of cross feed

JOB SHEET #7

b. Turn tool post so that tool points away from chuck at 45° to axis of work; secure (Figure 72)

FIGURE 72

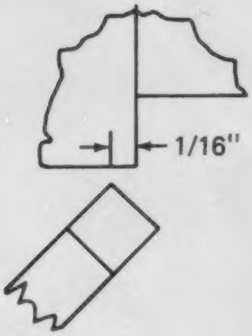

Chuck Jaw
Work
45°
Square-Nose Tool
Tool Post
Toolholder

JOB SHEET #7

c. Position tool at corner of shoulder, 1/16" from edge (Figure 73)

(NOTE: Tool must be positioned at a 45° angle to work.)

FIGURE 73



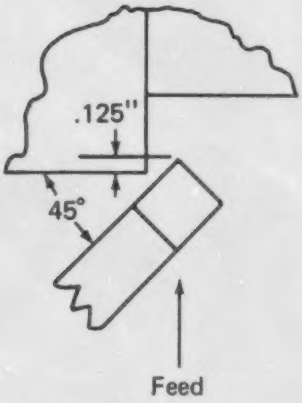
d. Set rpm at 190 and start spindle

e. Advance tool with cross feed until it starts to cut surface area to be chamfered

f. Move tool clear of work with carriage handwheel, zero graduated collar on cross feed, then advance tool with cross feed the depth of chamfer, 0.125" (Figure 74)

(NOTE: Depending on how cross feed dial is graduated, dial may read 125 or 250.)

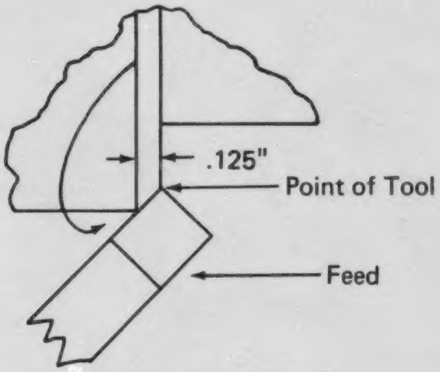
FIGURE 74



JOB SHEET #7

g. Feed tool into work with carriage handwheel until point of tool reaches machined face (Figure 75)

FIGURE 75



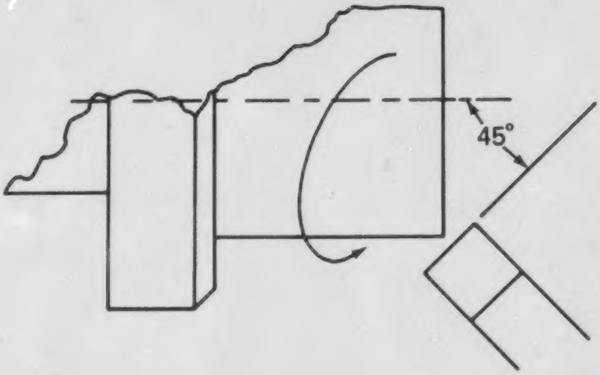
h. Stop spindle and inspect chamfer; recut as necessary

5. Form a chamfer with end of tool

a. Turn tool post 90° counterclockwise

b. Position carriage so that end of tool is centered on edge of work end at a 45° angle to axis of work and about 1/8" from work (Figure 76)

FIGURE 76

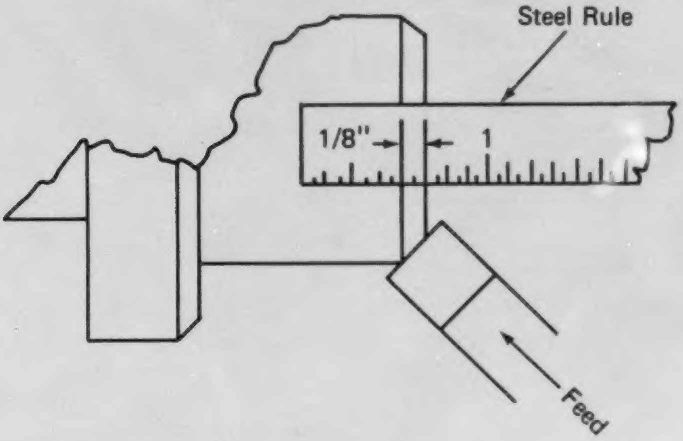


c. Start spindle

JOB SHEET #7

d. Advance tool into work with compound handwheel until a chamfer that measures 1/8" is produced (Figure 77)

FIGURE 77



e. Stop spindle and inspect chamfer

B. File a chamfer

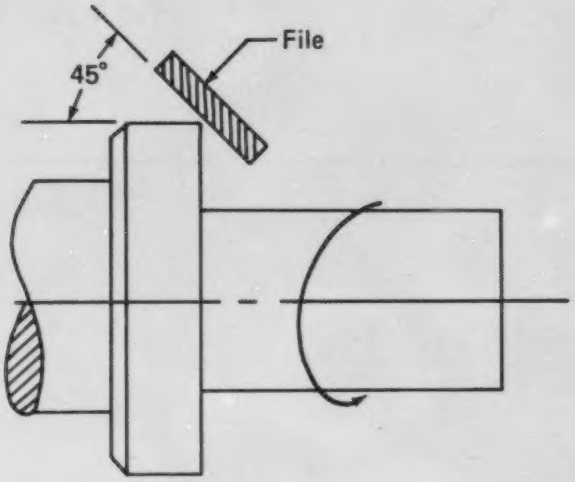
1. Turn work end-for-end, chuck, and align with indicator
2. Set rpm at 400 and start spindle
3. Hold file in left hand

(CAUTION: Always file using your left hand. Never place your left arm over revolving chuck, and always use a file equipped with a file handle to avoid possible stab wounds caused by the exposed tang of the file.)

JOB SHEET #7

4. Position file over edge of shoulder and tilt the file at approximately a 45° angle to surface (Figure 78)

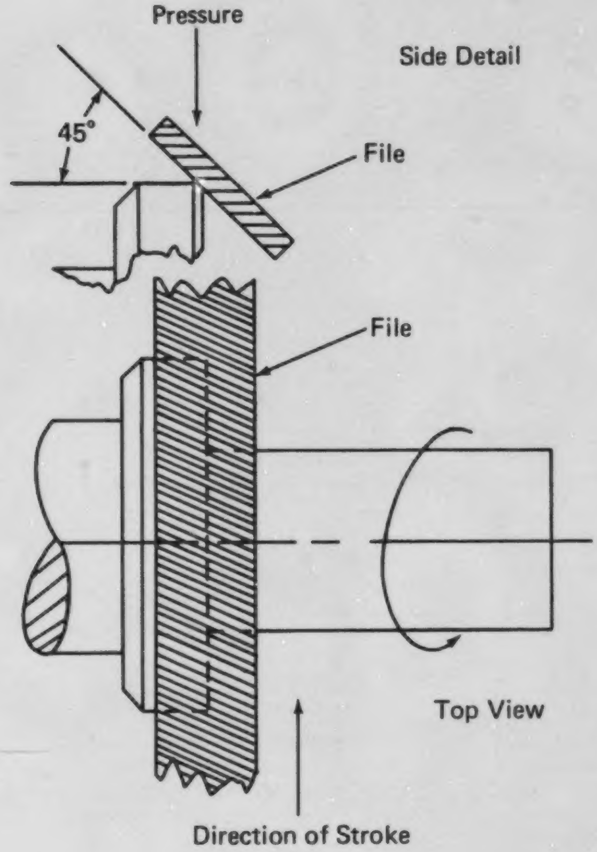
FIGURE 78



JOB SHEET #7

5. Bring file into contact with revolving work; apply pressure by placing right hand near end of file; push file forward (Figure 79)

FIGURE 79


Pressure
Side Detail
45°
File
File
Top View
Direction of Stroke

6. Examine chamfer; repeat filing as necessary

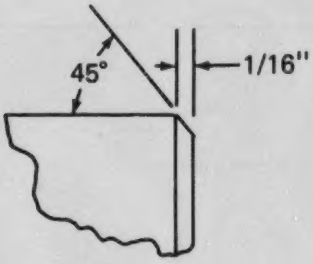
   (NOTE: After each forward stroke, lift file off the work, move file back, place on work, and make another forward stroke. Never drag file on work when making the backward movement, as this will dull the file.)

JOB SHEET #7

7. Continue to file until chamfer is 1/16" X 45° (Figure 80)

   (NOTE: Chamfers that are filed are usually 1/16" or less.)

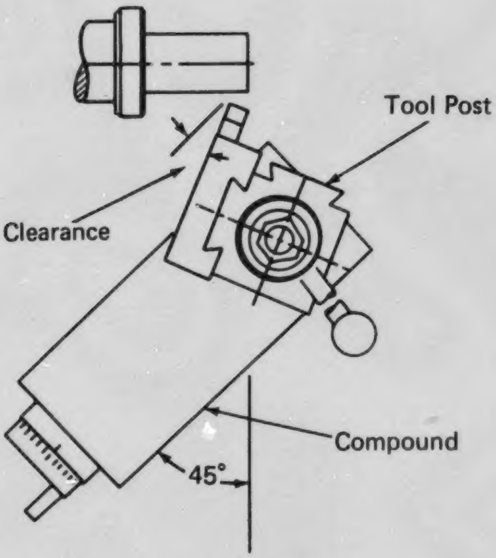
FIGURE 80



C. Cut a chamfer

1. Set compound 45° to left of cross slide
2. Set tool so that it will have clearance for cutting edge with tool on center height (Figure 81)

FIGURE 81

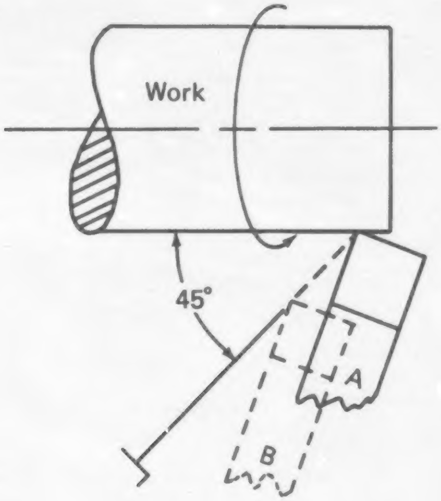

Tool Post
Clearance
Compound
45°

3. Set lathe rpm at 250, and start spindle

JOB SHEET #7

4. Position tool and advance it with cross feed until it starts to cut work (Figure 82)

FIGURE 82



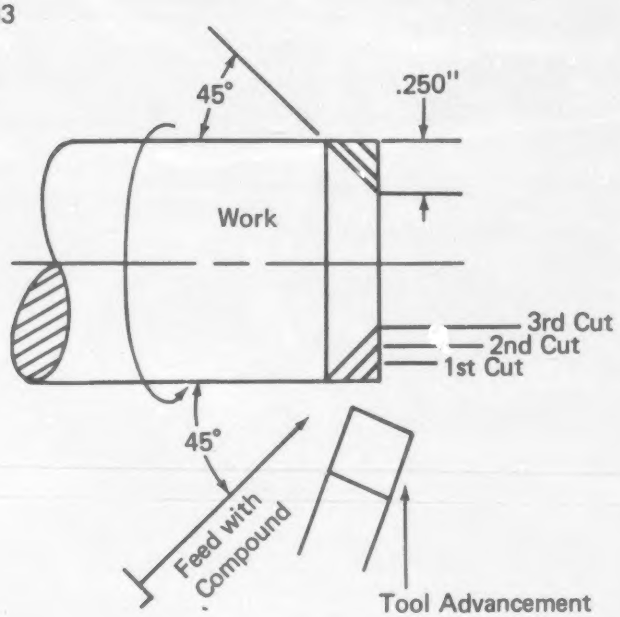
5. Crank carriage handwheel clockwise, moving tool away from work, and zero graduated collar of cross feed

JOB SHEET #7

6. Advance tool 0.100" with cross feed; advance tool with carriage handwheel until it just starts to cut; retract compound by rotating compound handwheel counterclockwise until tool stops cutting (Figure 83)

   (NOTE: Depending on how cross feed dial is graduated, dial may read 100 or 200.)

FIGURE 83


45°
.250"
Work
3rd Cut
2nd Cut
1st Cut
45°
Feed with Compound
Tool Advancement

7. Rotate compound handwheel clockwise, feeding back in across surface just cut until cutter clears end of work
8. Advance tool 0.100" and make second cut
9. Repeat Step 7
10. Advance tool 0.050" and make third cut

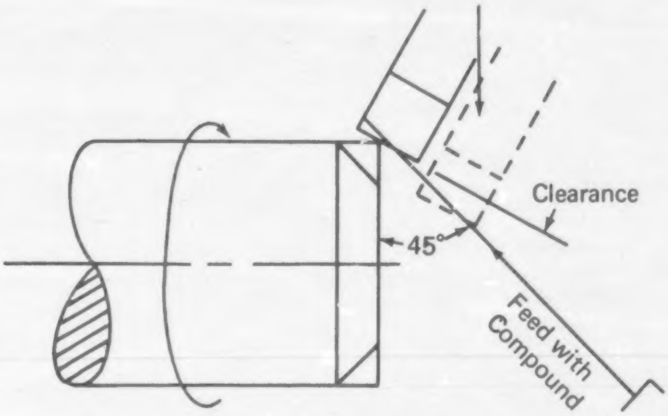
JOB SHEET #7

11. Stop spindle and check chamfer; recut as necessary

    (NOTE: Chamfers can be put on work several other ways and with other shapes of tools [Figure 84]. Chamfers can also be done on inside diameters, using these same principles.)

FIGURE 84

Cutting from backside with lathe turning in reverse



D. Turn off power; clean machine and put away all tools

   (NOTE: This operation will be evaluated at completion of Job Sheet #8.)

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #8--PERFORM RECESSING OPERATIONS

I. Tools and materials

A. Recessing tool, 1/8" wide, or cutoff blade, 1/8" wide, and blade holder

B. Steel rule, 6"

C. Lathe with chuck and tailstock center

D. Quick-change tool post and toolholder

E. Wrenches for chuck, tool post, toolholders, and carriage

F. Cutting oil

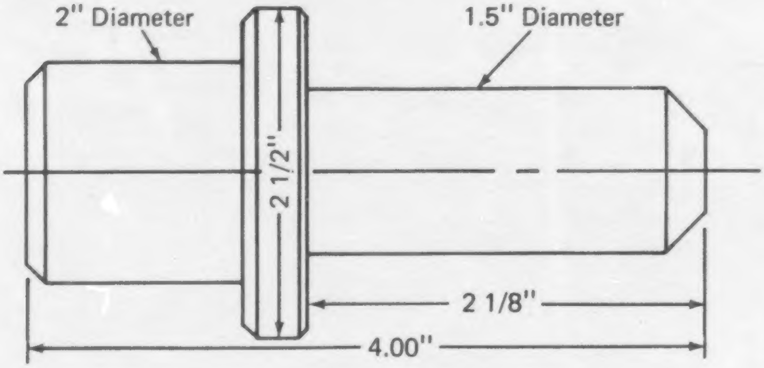
G. Vernier calipers

H. Clean shop cloth

I. Steel bar, SAE 1018, 2 1/2" diameter, 4" long (Figure 85)

(NOTE: This material has been used for previous job sheets.)

FIGURE 85



II. Procedure

A. Check oil levels and perform daily maintenance

B. Cut a thread recess

1. Chuck on 2.0" diameter of work

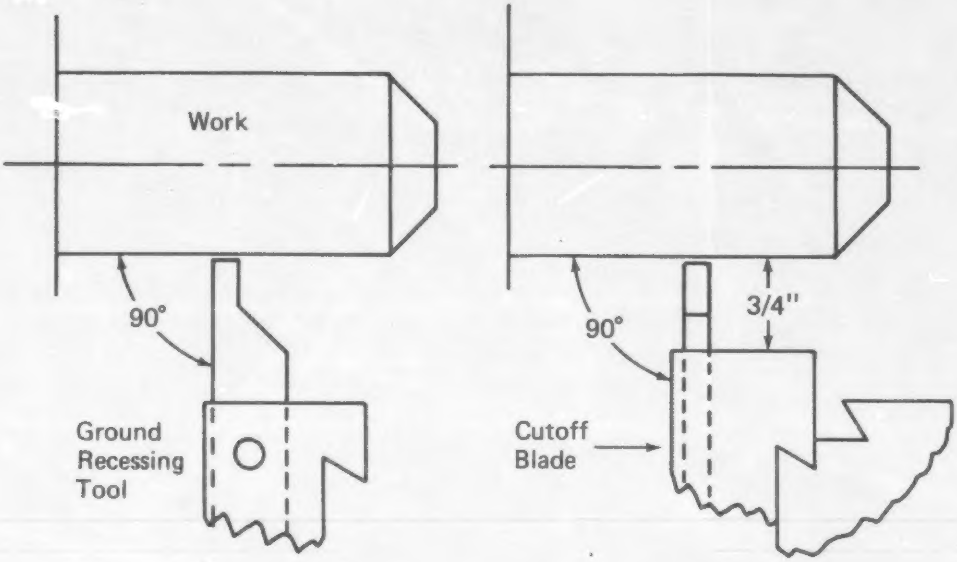
2. Mount recessing tool or cutoff blade in toolholder, mount toolholder on tool post, and adjust to center height

JOB SHEET #8

3. Position end of tool square to work (Figure 86)

   (NOTE: If using a cutoff blade, keep blade as short as possible.)

FIGURE 86

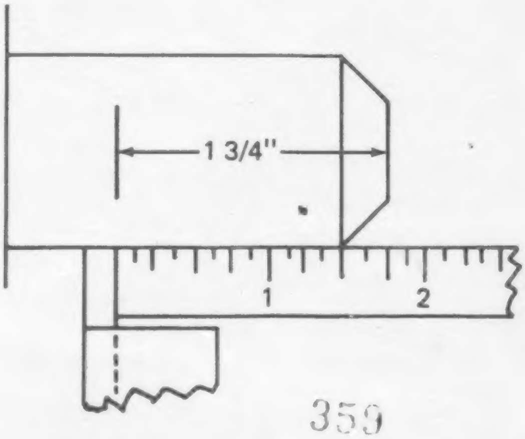

Work
90°
Ground Recessing Tool
90°
3/4"
Cutoff Blade

4. Set speed at 176 rpm

5. Use steel rule to set tool 1 3/4" from end of work (Figure 87)

   (NOTE: Depending on the accuracy of location of the recess, depth micrometers, way indicators, travel dial, or other tools may be used to determine location of recess.)

FIGURE 87



JOB SHEET #8

6. Back tool away from work and snug carriage lock to prevent carriage from moving and possibly causing tool bind

7. Turn on lathe, start spindle, and crank cross feed until tool starts to cut surface of work

8. Stop spindle, and zero cross feed graduated collar

9. Check thread depth charts, or calculate single depth of thread for eight threads

   (NOTE: This procedure produces sharp-V threads. The constant for computing single depth of thread for this form is 0.866.)

   EXAMPLE: Single depth of thread $= \frac{0.866}{N}$

   $$= \frac{0.866}{8}$$

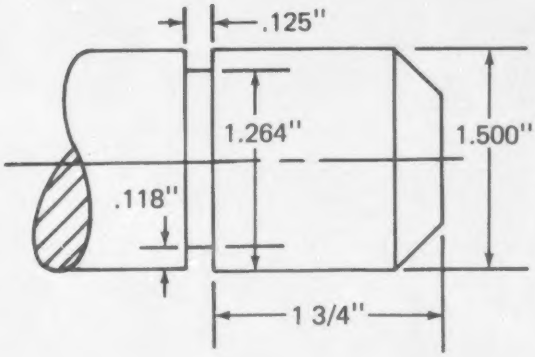
   $$= 0.108''$$

10. Start spindle and advance blade into work with a slow, continuous motion; at the same time, apply cutting oil

11. Continue to feed tool until graduated collar shows that tool has moved 0.118", which is 0.010" more than single depth of thread (Figure 88)

    (NOTE: Depending on how cross feed dial is graduated, dial may read 118 or 236.)

FIGURE 88



12. Stop spindle and inspect recess; check depth with calipers; recut as necessary

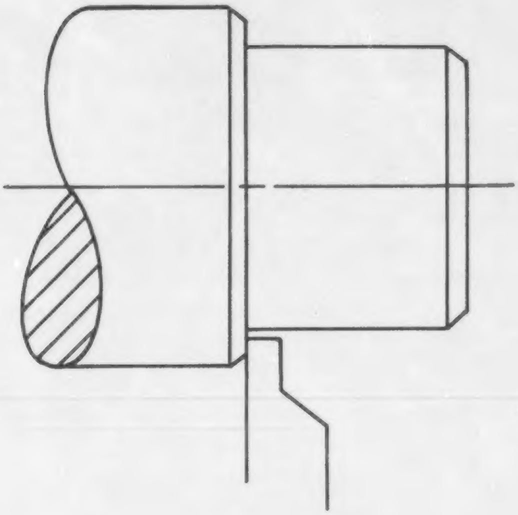
    (NOTE: Root diameter should measure 0.236" less than the major diameter.)

JOB SHEET #8

C. Cut a shoulder recess

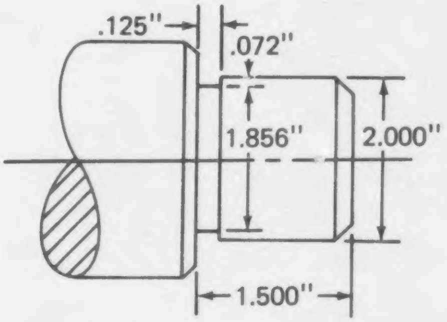
1. Turn work end-for-end and chuck
2. Position tool square to work
3. Position tool next to shoulder (Figure 89)

FIGURE 89



4. Set rpm at 120
5. Start spindle
6. Advance tool with cross feed until it just shaves 2.0" diameter; zero graduated collar
7. Advance cross feed and feed tool 0.072"; apply cutting oil as required during cutting (Figure 90)

FIGURE 90



JOB SHEET #8

8. Check depth of recess; recut as necessary

   (NOTE: Recesses for special applications may require grinding of a special tool.)

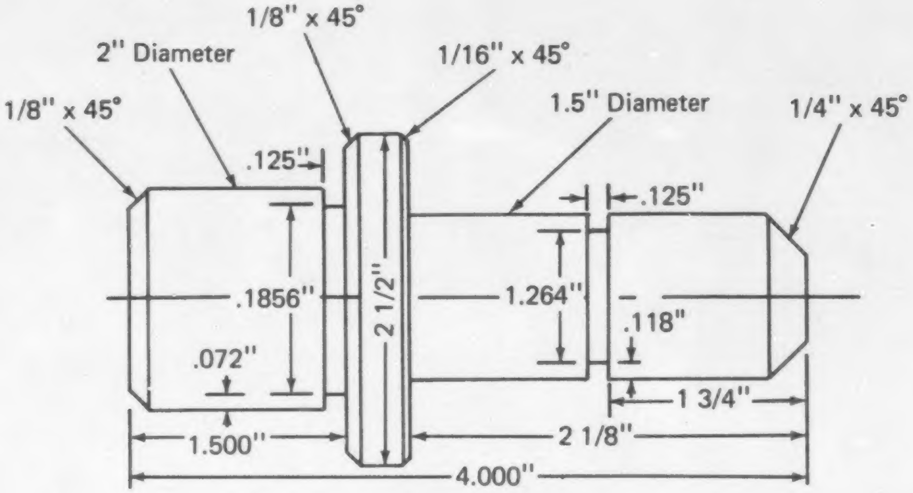
   EXAMPLES: Snap ring groove; O-ring seat

D. Turn off and clean machine, put away tools, and complete evaluation sheet on following page

E. Turn in work to instructor with evaluation sheet

JOB SHEET #8--EVALUATION SHEET

NAME____________________________________ SCORE ________________


1/8" x 45°
2" Diameter
1/8" x 45°
1/16" x 45°
1.5" Diameter
1/4" x 45°
.125"
.125"
.1856"
2 1/2"
1.264"
.118"
.072"
1 3/4"
1.500"
2 1/8"
4.000"

Job Sheet #7	In Tolerance	Out of Tolerance
1/8" x 45° chamfer		
1/8" x 45° chamfer		
1/16" x 45° chamfer		
1/4" x 45° chamfer		

Job Sheet #8		
1.856" recess		
1.264" recess		

Remarks____

____

____

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #9--PERFORM A CENTER-DRILLING OPERATION

I. Equipment and materials

- A. Combination drill and countersinks, #3 and #5
- B. Lathe with chuck
- C. Drill chuck and key, 1/2" capacity with arbor to fit tailstock
- D. Wrenches for chuck and drill chuck
- E. Cutting oil
- F. Steel bar, SAE 1018, 2 1/2" diameter, 4" long

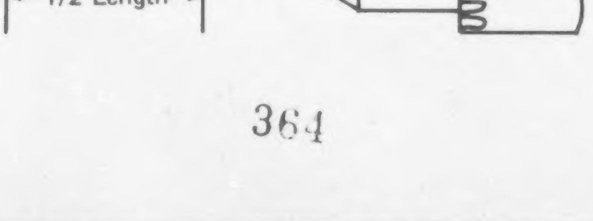
  (NOTE: This is the same material used for Job Sheet #8.)
- G. Clean shop cloth

II. Procedure

- A. Check oil levels and perform daily maintenance
- B. Chuck work on 1.500" diameter in chuck
- C. Clean taper and install drill chuck

  (CAUTION: Make sure that the spindle of the tailstock is clean and is turned out of the tailstock housing about 3/4" so that tang is lined up before seating.)
- D. Put center drill in drill chuck so that half or more of center drill length is in jaws of drill chuck (Figure 91)

FIGURE 91

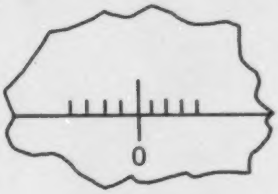


JOB SHEET #9

E. Check for alignment of witness mark located on back of the tailstock where upper and lower castings meet (Figure 92)

(NOTE: If witness mark looks out of alignment, the instructor will adjust if necessary.)

FIGURE 92



F. Slide tailstock forward with spindle out about 3/4" until center drill is 1/4" from the end of work; lock tailstock in place

G. Use the formula and chart below to calculate rpm

$$\text{rpm} = \frac{4 \times CS}{\text{Diameter of Point}} \div 3$$

(NOTE: Center drill rpm should be about one-third of drill rpm; the diameter of the work determines the size of center drill.)

Number of Center Drill	Diameter of Work	Drill Point Diameter	Body Size
#1	3/16 to 5/16	3/64	1/8
#2	3/8 to 1/2	5/64	3/16
#3	5/8 to 3/4	7/64	1/4
#4	1 to 1 1/2	1/8	5/16
#5	2 to 3	3/16	7/16
#6	3 to 4	7/32	1/2
#7	4 to 5	1/4	5/8
#8	6 to --	5/16	3/4

EXAMPLE: Material 1018, cutting speed = 90 sfpm
Diameter of point of #3 = 7/64" = 0.109"

$$\frac{4 \times 90}{0.109} \div 3 = 1101 \text{ rpm}$$

(NOTE: The cutting speed was determined by using the charts following Information Sheet in Unit II.)

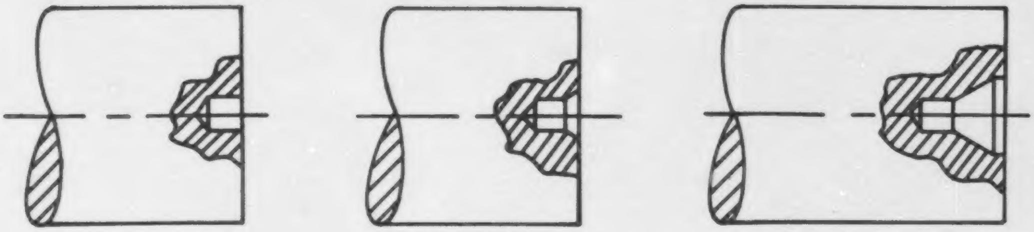
H. Set speed at 1100 rpm; start spindle turning forward

I. Turn tailstock handwheel slowly, feeding center drill into work; apply cutting oil to aid in cutting action of center drill and to produce a smooth hole

JOB SHEET #9

J. Continue to feed center drill until it has produced a center hole about one-half the length of tapered portion of center drill (Figure 93); inspect and redrill as required

FIGURE 93



Not Deep Enough Correct Too Deep

K. Stop spindle, turn part end-for-end, and rechuck

L. Remove #3 center drill from drill chuck and replace with #5 center drill

M. Repeat steps F through J with proper rpm to produce and center drill hole in other end of work

N. Turn off power, clean machine, and put away all tools

(NOTE: The work will be used again in Job Sheet #18.)

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #10--PERFORM A KNURLING OPERATION

I. Equipment and materials

   A. Medium knurling tool, diamond pattern

   B. Lathe with chuck and tailstock center

   C. Quick-change tool post and toolholders

   D. Wrenches for chuck and toolholders

   E. Steel rule, 6"

   F. Steel bar, SAE 1018, 1" diameter, 4" long

   G. Facing tool

   H. Cutting oil

   I. Brush and solvent

   J. Lubricant

   K. Clean shop cloth

II. Procedure

   A. Check oil levels and perform daily maintenance

   B. Chuck work with 2 3/4" protruding past chuck jaws

   C. Face end

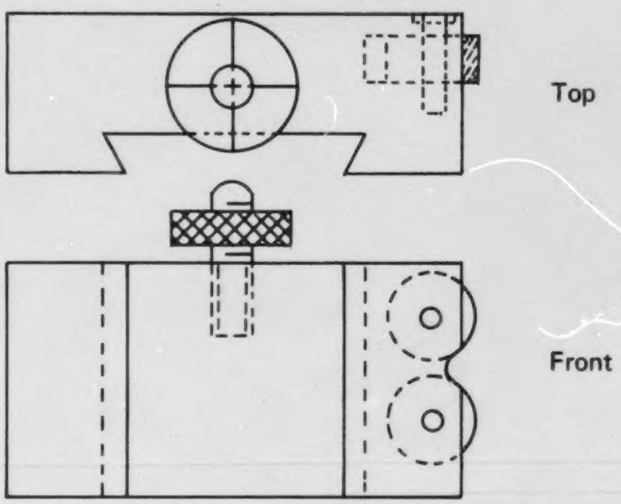
   D. Clean knurling rollers with brush and solvent, and then lubricate

JOB SHEET #10

E. Mount knurling tool on tool post

(NOTE: There are several kinds of knurling tools; for this job sheet, use the fixed-holder type for quick-change tooling. See Figure 94.)

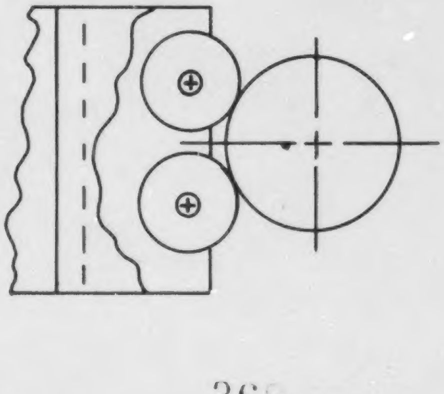
FIGURE 94



F. Adjust knurling tool to center height; lock

(NOTE: If knurling tool is on center, both rollers will make contact with surface of work at the same time, with the center axis of the work aligned with the midpoint between the rollers. See Figure 95.)

FIGURE 95



JOB SHEET #10

G. Set the feed for a medium-grade knurl

(NOTE: Knurls have three grades of coarseness: fine, medium, and coarse.)

EXAMPLES: Fine--32 pitch or 0.031 ipr feed
Medium--20 pitch or 0.050 ipr feed
Coarse--13 pitch or 0.076 ipr feed

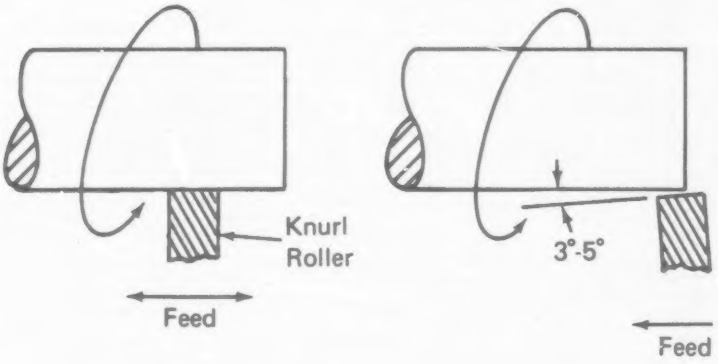
H. Set knurling rpm at about 1/4 the turning rpm for the same size and type of material

EXAMPLE: A 1" medium carbon steel rod will turn at 300 rpm; 1/4 of 300 is 75 rpm.

I. Loosen tool post and adjust rollers of knurling tool so that they are square to work (Figure 96)

(NOTE: When knurling hard material, rollers are set 3° to 5° off square.)

FIGURE 96



JOB SHEET #10

1. Check tool for squareness by placing a strip of paper between work and rollers

2. Advance cross feed until there is slight pressure on paper

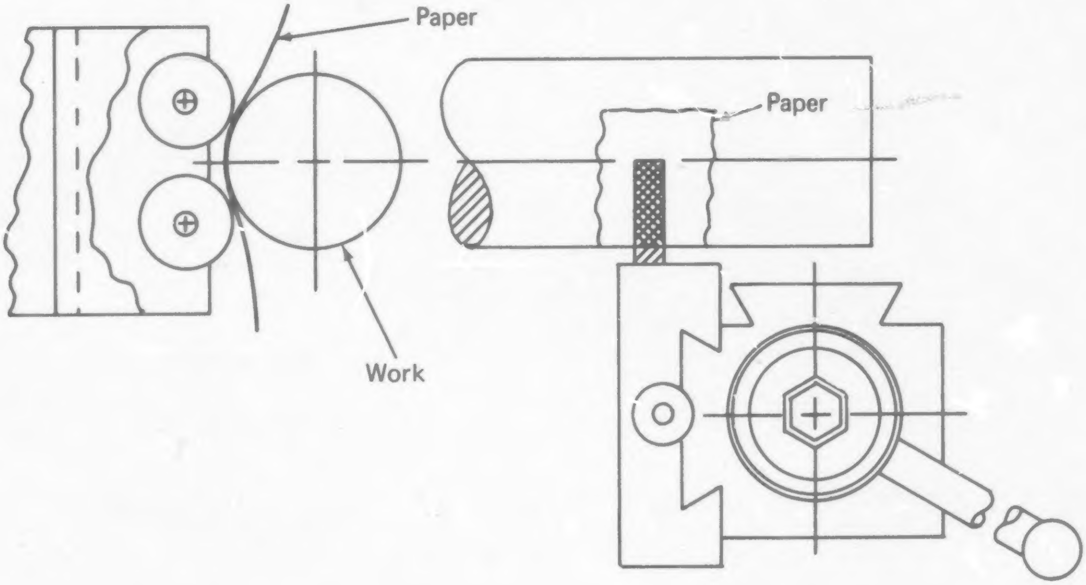
3. Place spindle in neutral and revolve chuck by hand

4. Inspect paper

   (NOTE: If tool is square and on center height, a clear diamond pattern will be produced the width of the rollers. Double-tracking [twice as many lines in one direction as in the other direction] occurs when knurling tool is not on center or rollers are dirty [Figure 97].)

5. Adjust as necessary

FIGURE 97

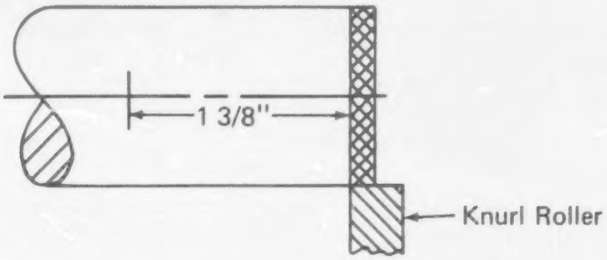


J. Mark a line 1 3/8" from end of work

JOB SHEET #10

K. Engage spindle and position tool so that half of roller is on work; advance cross feed until tool begins to form a diamond pattern (Figure 98)

FIGURE 98



L. Apply cutting oil to rollers and work

(CAUTION: Do not get brush or tip of oil can close to rollers, and never touch rollers while they are revolving. Objects caught between rollers and work will be pulled through or may damage rollers or work.)

M. Engage power feed and allow carriage to move until rollers reach 1 3/8" line

N. Stop spindle and examine knurl; if knurls have not peaked out, apply oil, start spindle, and move tool back across knurling

(CAUTION: Do not allow rollers to move past end of work.)

O. Repeat steps L through N as necessary with a deeper feed until knurls peak out

P. Stop spindle and clean tool

Q. Mark a line 1 3/4" from end of work and another line 2 1/4" from end; center rollers between lines

R. Start spindle, advance knurling tool, and apply cutting oil to rollers; moving the carriage by hand to lines, repeat knurling procedure until knurls have peaked out

S. Stop spindle and clear tool from work

T. Turn off power and clean machine; clean knurling tool and put away all tools and materials

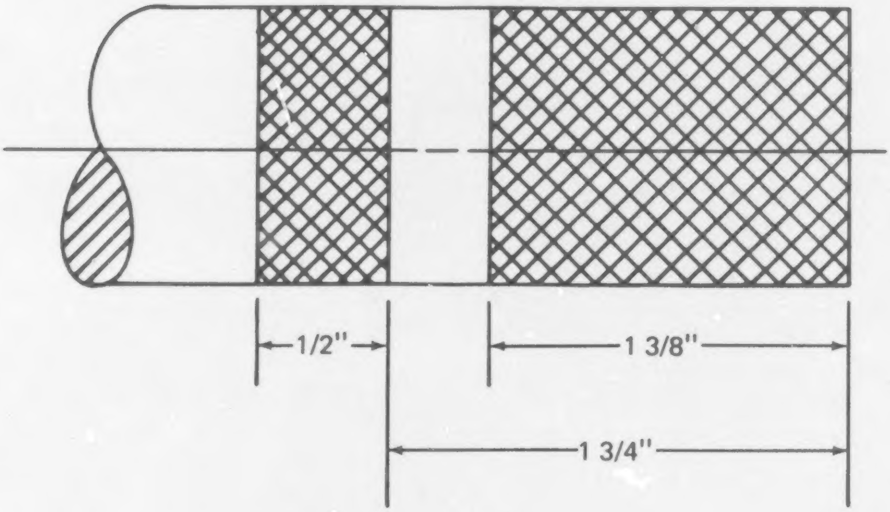
U. Complete evaluation sheet on following page

V. Turn in work and evaluation to instructor

JOB SHEET #10--EVALUATION SHEET

NAME________________________________ SCORE ________________

Medium Knurls



	Satisfactory	Unsatisfactory
Knurls		
1/2" length		
1 3/8" length		

Remarks____

____

____

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ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #11--DRILL AND REAM A HOLE

(NOTE: The job sheets on facing and center-drilling should be completed before starting this job sheet.)

I. Equipment and materials

   A. Facing tool
   B. Combination drill and countersink, #4
   C. Lathe with chuck and tailstock center
   D. Steel rule, 6"
   E. Drill chuck and key, 0" to 1/2" capacity with arbor to fit tailstock
   F. Wrenches for chuck, compound, and toolholder
   G. Quick-change tool post and toolholder
   H. Cutting oil
   I. Drill, 31/64"
   J. Reamer, 1/2" (0.500")
   K. Steel bar, SAE 1020, 2 1/2" diameter, 1 15/16" long
   L. Clean shop cloth

II. Procedure

   A. Check oil levels and perform daily maintenance
   B. Chuck work
   C. Face end of work
   D. Mount chuck on tailstock, and center drill work
   E. Insert 31/64" drill in drill chuck
   F. Set speed at 744 rpm

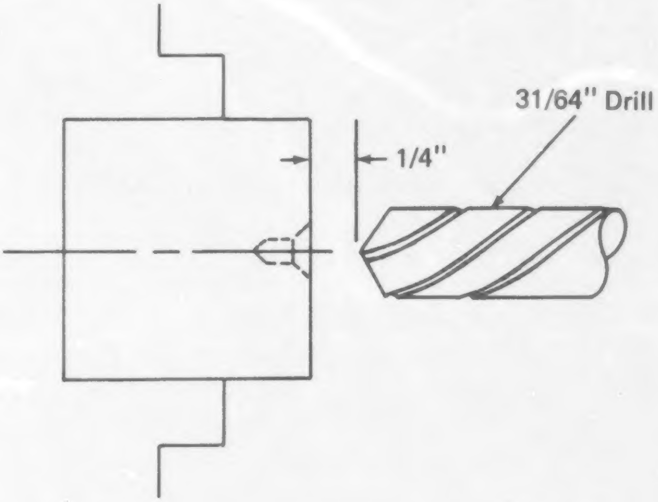
$$\text{rpm} = \frac{4 \times \text{CS}}{\text{Diameter of Drill}} = \frac{4 \times 90}{0.484} = 743.8$$

CS = 90 sfpm
4 = Constant
Diameter of drill = 31/64" = 0.484"

JOB SHEET #11

G. Position drill so that tailstock spindle is well into housing with point of drill about 1/4" from end of work (Figure 99); lock tailstock in place

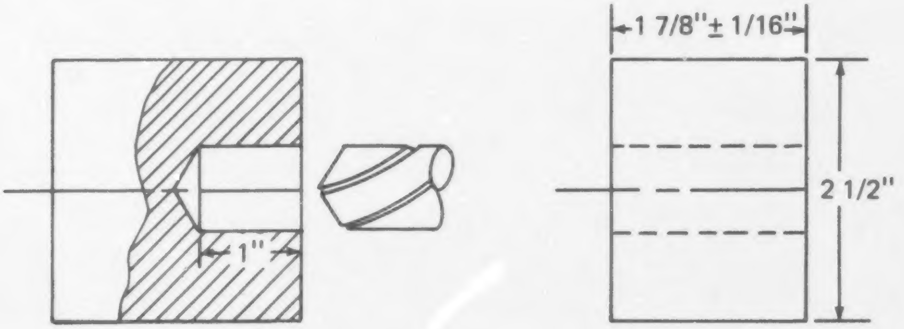
FIGURE 99



H. Start spindle and feed drill into work with tailstock handwheel; at the same time, apply cutting oil to drill

I. Continue to feed drill in about 1"; back drill out of hole to clear chips; apply more cutting oil, and continue drilling until hole is through work (Figure 100)

FIGURE 100



J. Withdraw drill and stop spindle

JOB SHEET #11

K. Remove, clean, and put away drill

(CAUTION: Use a cloth to remove drill from chuck because the drill will be hot.)

L. Insert 1/2" reamer in drill chuck; slide tailstock forward until reamer is 1/4" from stock; lock tailstock in place

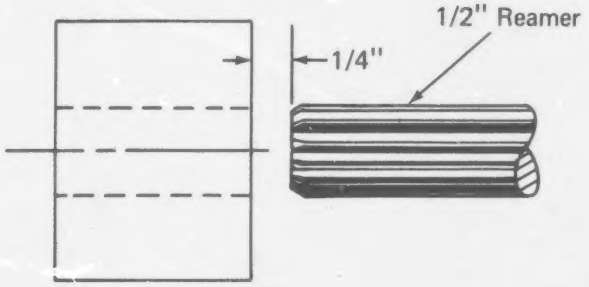
M. Set rpm for reaming

(NOTE: Reaming speeds should be about one-half of drilling rpm.)

N. Start spindle, apply cutting oil to reamer, and crank reamer into hole with tailstock handwheel, using a slow, continuous motion until reamer point has cut length of work; crank reamer out of hole (Figure 101)

CAUTION: Never ream a hole in which there is more than 1/16" difference between the diameter of the hole and that of reamer.)

FIGURE 101



O. Turn off power, clean machine, and put away all tools and materials

P. Turn in part to your instructor for evaluation

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #12--USE LATHE CENTER TO ALIGN AND START A TAP

I. Equipment and materials

   A. Lathe with chuck and tailstock center

   B. Taper tap, 1/2"-13NC

   C. Adjustable wrench, 6"

   D. Chuck wrench

   E. Cutting oil

   F. Drill chuck and key, 1/2" capacity, with arbor to fit tailstock

   G. Combination drill and countersink, #5

   H. Drill, 27/64"

   I. Hex or round steel bar, SAE 1018, 1" diameter, 1 1/2" long

   J. Tap wrench

   K. Bench vise

   L. Clean shop cloth

II. Procedure

   A. Check oil levels and perform daily maintenance

   B. Chuck work, leaving 3/4" protruding past chuck jaws

   C. Face end of work

   D. Center drill work

   E. Drill through work; remove drill and chuck

   (NOTE: Holes to be tapped must be drilled to a particular tap drill size.)

   F. Place center in tailstock

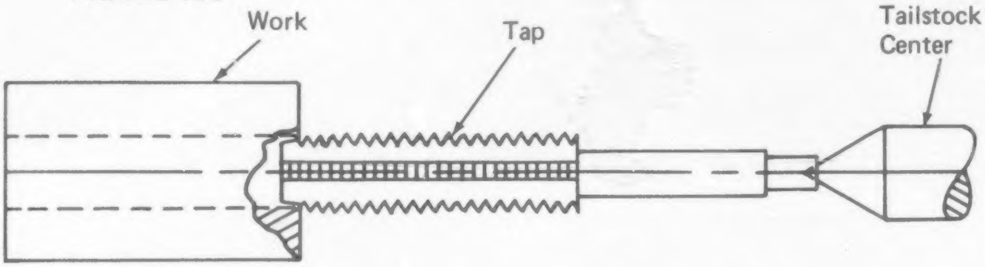
   G. Put lathe in back gear or in a low range to hold spindle so that it will not turn

JOB SHEET #12

H. Place point of tap in hole and hold in place with your left hand; slide tailstock forward with your right hand, and guide center into center hole of tap; lock tailstock in place (Figure 102)

(NOTE: Small taps, and taps that do not have center holes, are held in tap handles that have center holes; tap handles may be turned to screw taps into work.)

FIGURE 102



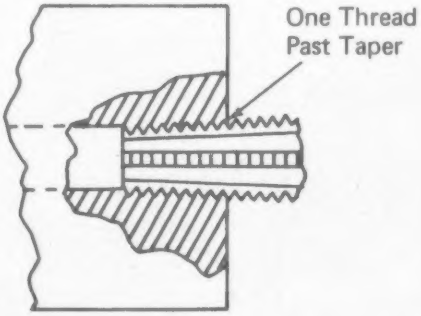
I. Place a few drops of cutting oil on tap

J. Use adjustable wrench to turn tap with your left hand, advancing spindle of tailstock to keep center in contact with tap

K. Continue to guide tap in this manner until it is one thread past the tapered portion of tap (Figure 103)

(NOTE: This method guides the tap in a straight line with the hole.)

FIGURE 103



L. Remove work from chuck and finish tapping part by hand in bench vise

M. Clean chips and oil from tap and drills; put away all tools, and turn in part to instructor

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #13--PERFORM CUTOFF OPERATION

I. Equipment and materials

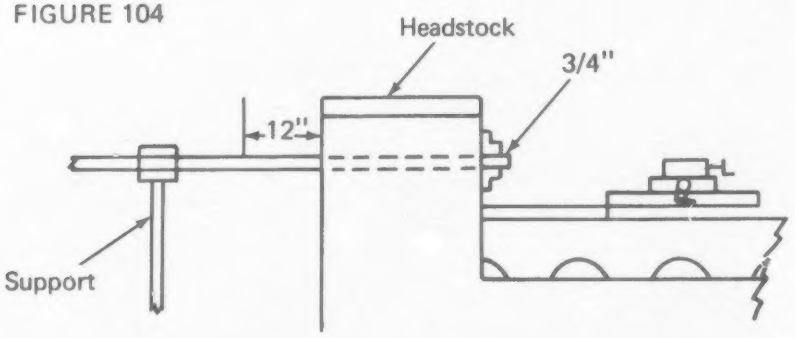
- A. Cutoff blade, 1/8", and holder
- B. Lathe with chuck
- C. Quick-change tool post and toolholders
- D. Steel rule, 6"
- E. Cutting oil
- F. Steel bar, SAE 1018, 1/2" diameter, 8.0' to 10.0' long
- G. Facing tool
- H. Wrenches for compound, tool post and holders, and chuck
- I. Clean shop cloth

II. Procedure

- A. Check oil levels and perform daily maintenance
- B. Chuck work so that 3/4" protrudes from chuck jaws; face end smooth (Figure 104)

(CAUTION: If work extends through spindle more than 1 foot, it must be supported.)

FIGURE 104

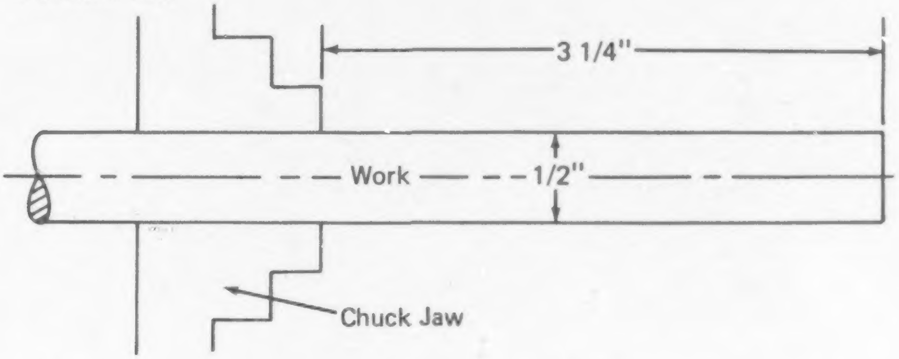


(NOTE: Cutoff operations should be performed as close to the chuck or collet as possible.)

JOB SHEET #13

C. Stop spindle and slide work out so that 3 1/4" extends from end of chuck jaw (Figure 105)

FIGURE 105

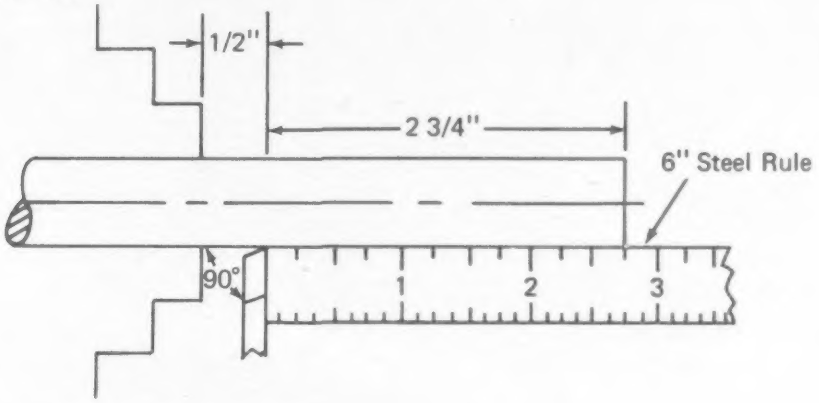


D. Mount cutoff blade and holder on tool post and set to center height

E. Square cutoff blade to work; set cutoff blade 2 3/4" from end of work (Figure 106)

(CAUTION: Cutoff should never be done if cut is more than diameter of work from end of chuck jaw.)

FIGURE 106



F. Set lathe speed at 880 rpm

(NOTE: Determine rpm according to the cutoff chart in Unit II.)

EXAMPLE:

$$\text{rpm} = \frac{4 \times \text{CS}}{\text{Diameter}} = \frac{4 \times 110}{0.5} = 880 \text{ rpm}$$

JOB SHEET #13

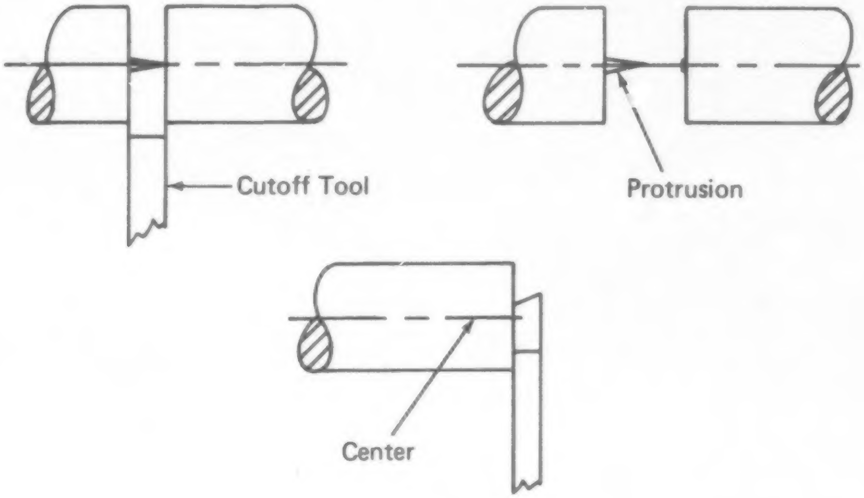
G. Lock carriage and start spindle

H. Feed tool into work with cross feed, using a slow, continuous motion; at the same time, apply cutting oil

(NOTE: The machine can be set to power-feed the cutoff tool by setting feed mechanism at 0.0015 ipr.)

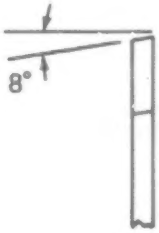
I. Feed tool into work until the part being cut falls off; continue to feed tool past center to remove protrusion (Figure 107)

FIGURE 107



(NOTE: The cutoff tool is ground to leave a minimum of material on work. See Figure 108.)

FIGURE 108



J. Loosen chuck, slide part out 3 1/4", and tighten chuck

JOB SHEET #13

K. Cut another part by repeating steps E through I as required

L. Turn off power, clean machine, and put away all tools

M. Turn in parts to instructor for evaluation

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #14–TURN BETWEEN CENTERS

(NOTE: Job sheets on facing, center drilling, and turning are prerequisites for this job sheet.)

I. Equipment and materials

  A. Right-hand turning tool

  B. Steel rule, 6"

  C. Live center

  D. Spindle adapter

  E. Drive plate

  F. Ball-bearing center for tailstock

  G. Quick-change tool post and toolholders

  H. Bent-tail lathe dog or clamping lathe dog and wrenches

  I. Wrenches to remove chuck, and for tool post and compound

  J. Clean shop cloth

  K. Steel bar, SAE 4140, 1 1/2" diameter, 7" long

  L. Lubricating oil

  M. Micrometer, 1" to 2"

  N. Cutting oil

  O. Combination drill and countersink, #4

  P. Drill chuck and key with arbor to fit tailstock

  Q. Facing tool

  R. Dial indicator

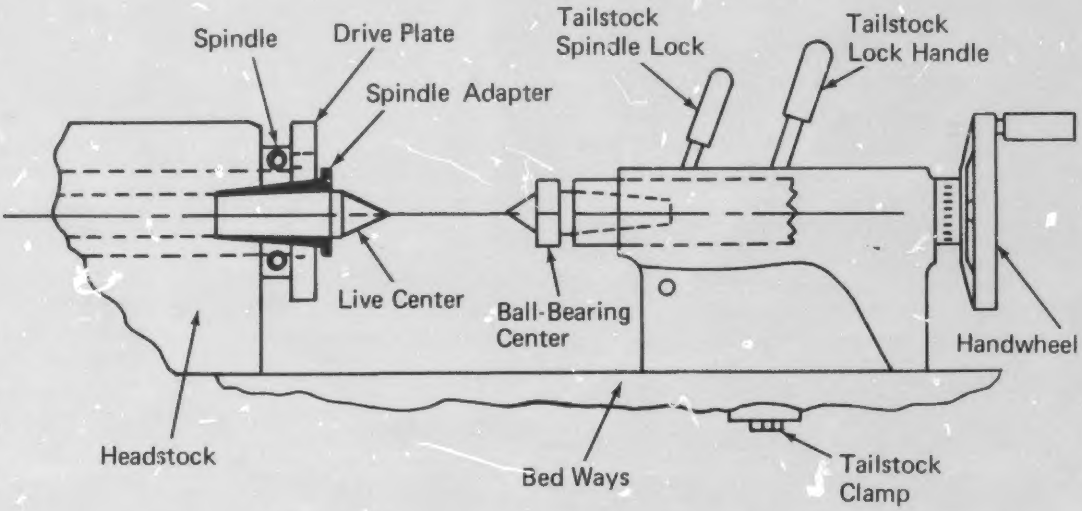
  S. Pencil

JOB SHEET #14

II. Procedure

- A. Check oil levels and perform daily maintenance
- B. Chuck work in lathe
- C. Face end smooth
- D. Center drill end of work
- E. Turn end-for-end and face to 6 3/4" long
- F. Center drill end and remove work from chuck
- G. Remove lathe chuck and drill chuck
- H. Set up lathe to turn between centers (Figure 109)

FIGURE 109


Spindle
Drive Plate
Spindle Adapter
Tailstock Spindle Lock
Tailstock Lock Handle
Live Center
Ball-Bearing Center
Handwheel
Headstock
Bed Ways
Tailstock Clamp

1. Wipe out spindle
2. Wipe off spindle adapter and apply a thin coat of oil; seat adapter in spindle
3. Mount drive plate to spindle nose; secure in place
4. Wipe off live center; oil and seat in spindle adapter
5. Check to see if live center is running true; if not, remove, clean all surfaces, and reseat; then check again for alignment

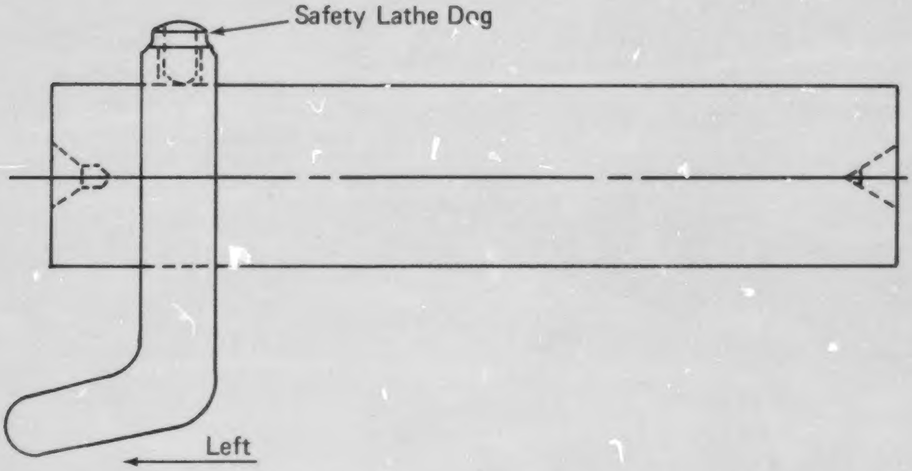
   (NOTE: This check can be done with a dial indicator.)

JOB SHEET #14

6. Clean taper in tailstock, wipe off ball-bearing center, and seat in tailstock

I. Put lathe dog on work so that tail of dog is pointing to left (Figure 110)

FIGURE 110



J. Crank spindle of tailstock out about 1 1/2"; make sure spindle lock and tailstock lock are loose

K. Place center-drilled hole on live center with lathe dog tail to left; hold in place with your left hand

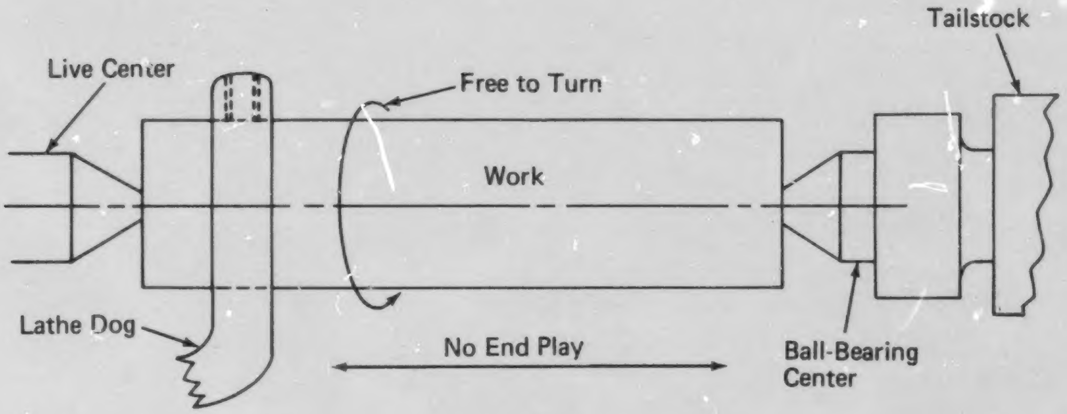
L. Slide tailstock up; guide ball-bearing center into hole and lock tailstock spindle in place

JOB SHEET #14

M. Turn tailstock handwheel to lock part between centers with pressure; loosen pressure until work turns freely by hand on centers

(NOTE: Work should not have any end play. See Figure 111. The purpose for the face movement of work is to allow for expansion of material as it gets hot from turning.)

FIGURE 111


Tailstock
Live Center
Free to Turn
Work
Lathe Dog
No End Play
Ball-Bearing Center

N. Slide tail of lathe dog into slot in drive plate and tighten lathe dog in place

(CAUTION: Tail of dog should fit freely in slot.)

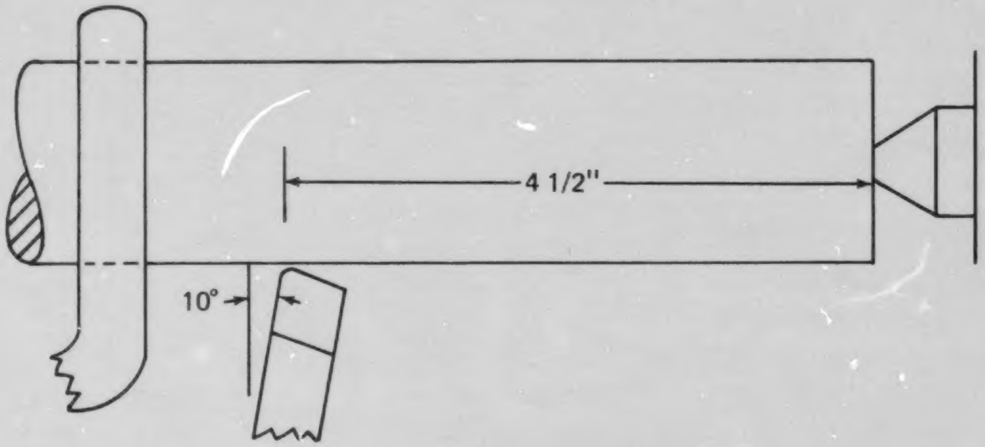
O. Mount turning tool in toolholder and adjust to center height

P. Set tool so that cutting edge has about a 10° lead angle

JOB SHEET #14

Q. Mark line on work with pencil 4 1/2" from end near tailstock; put point of tool at this line and turn work a complete revolution by hand to make sure tool can cut this far and still have clearance between lathe dog and tool post (Figure 112)

FIGURE 112



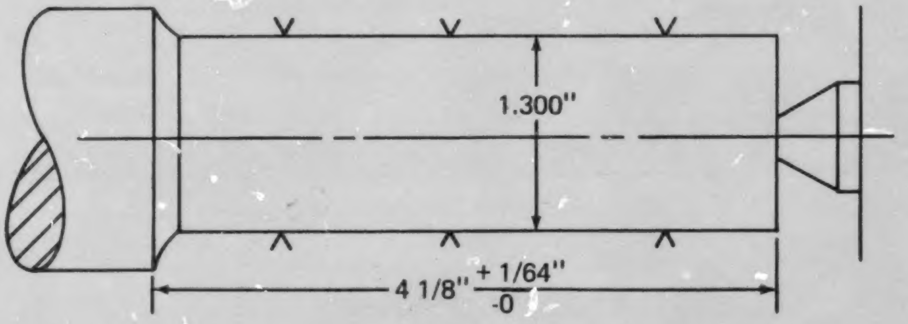
R. Move tool toward tailstock to see if point will clear end about 1/2"; if not, loosen tailstock crank spindle until carriage can move enough to clear tool; retighten and adjust work

S. Set spindle speed at 240 rpm with a feed rate setting of 0.015 ipr for rough turning

T. Start spindle and turn work to 1.300" x 4 1/8"; stop spindle and check work for straightness by checking diameters along length of work (Figure 113)

(NOTE: If work does not measure 1.300" ± 0.001" along the length, the tailstock may be out of alignment; if so, check with instructor.)

FIGURE 113



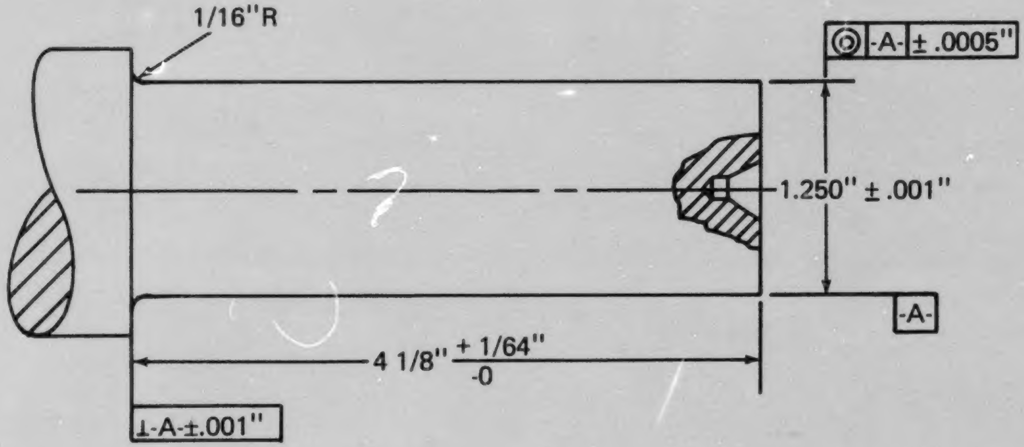
JOB SHEET #14

U. Turn work to a finished diameter of 1.250" ± 0.001" x 4 1/8" long with square shoulder having a radius of 1/16" (Figure 114)

(NOTE: For finish cut, speed should be increased to 384 rpm with a feed rate of 0.007 ipr.)

V. Face shoulder (Figure 114)

FIGURE 114



W. Stop spindle and check diameter; remove additional material if necessary

X. Turn off power, clean machine, and put away all tools

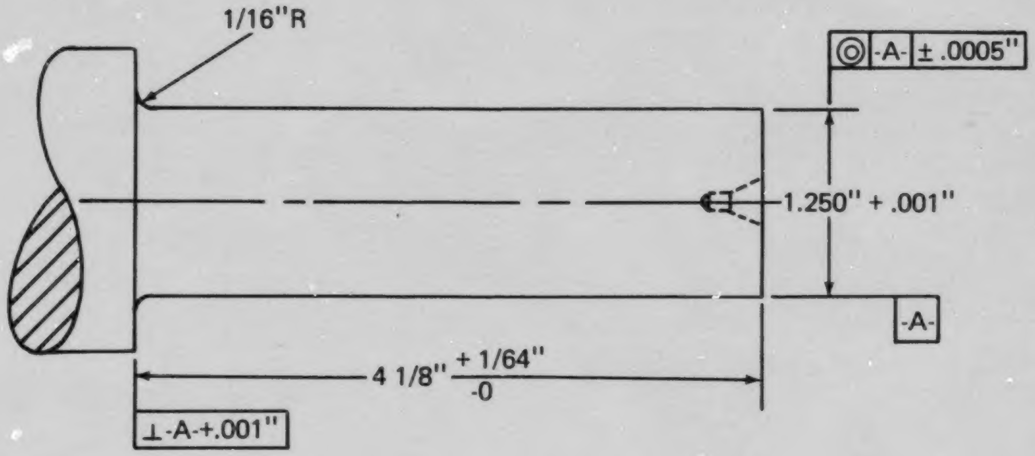
Y. Complete evaluation sheet on following page

Z. Turn in work and evaluation sheet to instructor

(NOTE: Save this work after evaluation; it will be used with Job Sheet #15.)

JOB SHEET #14--EVALUATION SHEET

NAME ______________________________ SCORE ______________


1/16"R
◎ -A- ± .0005"
1.250" + .001"
-A-
4 1/8" + 1/64" -0
⊥-A-+.001"

	In Tolerance	Out of Tolerance
Length 4 1/8" +1/64" -0.00"		
Diameter 1.250 ± 0.001		
1/16 Radius ± 1/32		
⊥-A- ± 0.001		
◎ to -A- ± 0.0005		

Remarks ____

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ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #15--TURN A TAPER WITH TAPER ATTACHMENT

I. Equipment and materials

- A. Right-hand turning tool
- B. Steel rule, 6"
- C. Live center
- D. Spindle adapter
- E. Drive plate
- F. Ball-bearing center for tailstock
- G. Quick-change tool post and toolholder
- H. Bent-tail lathe dog or clamping lathe dog and wrenches
- I. Wrenches for tool post, compound, carriage stop, and taper attachment
- J. Lubricating oil
- K. Dial indicator, 0.250" range
- L. Clean shop cloth
- M. Morse taper gauge, #4
- N. Micrometer, 1" to 2"
- O. Lathe with taper attachment and carriage stop
- P. Spacer, 2"
- Q. Cutting oil
- R. Prussian blue
- S. Steel part from Job Sheet #14

II. Procedure

- A. Check all oil levels and perform daily maintenance
- B. Set up lathe to turn between centers with drive plate
- C. Place lathe dog on large end of work (end not machined); place work between centers and adjust

JOB SHEET #15

D. Clean taper attachment with clean shop towel and apply a thin coat of lubricating oil

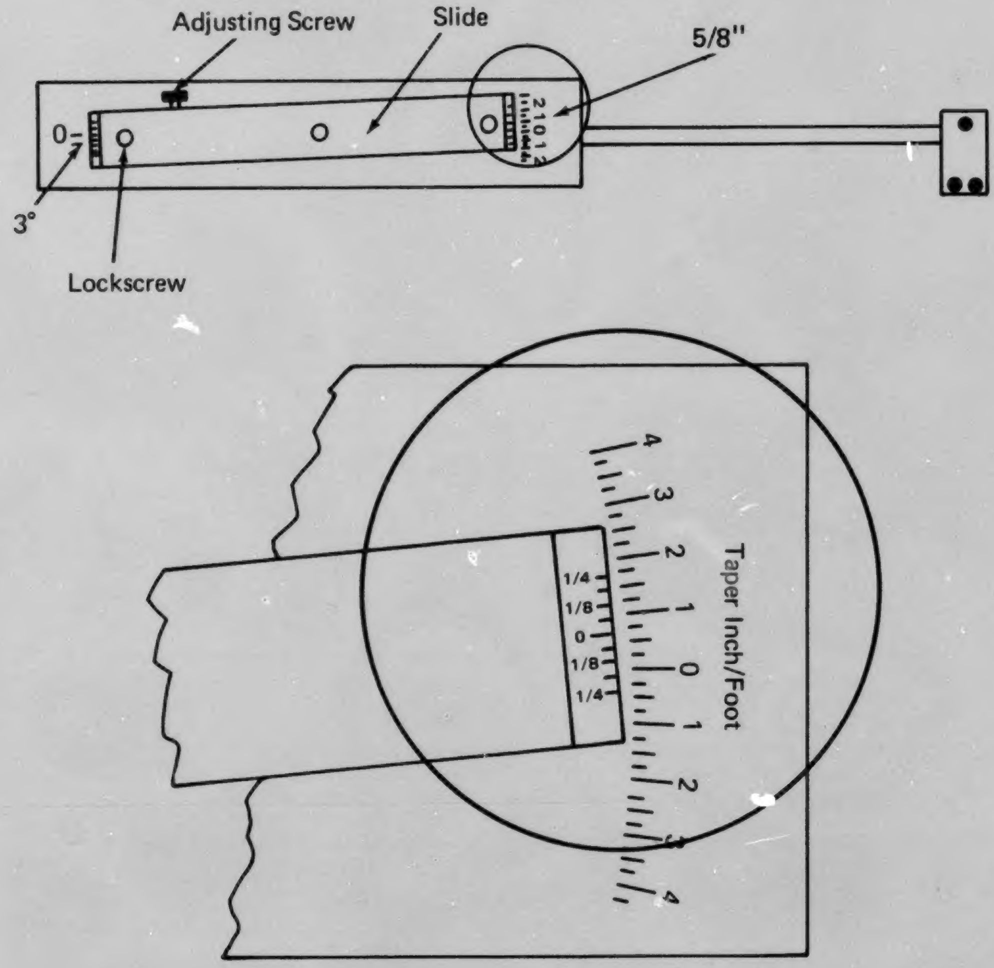
E. Mount taper attachment on lathe

F. Loosen lock screws on each end of taper attachment

G. Adjust taper attachment to almost 5/8" per foot by turning adjusting screw (Figure 115)

(NOTE: The taper of the plug gauge is 0.6232" per foot. Set the taper attachment just short of 5/8" [0.625"]. This should be done so that the right end of the taper attachment slide moves away from you because the large end of the taper is at the headstock.)

FIGURE 115

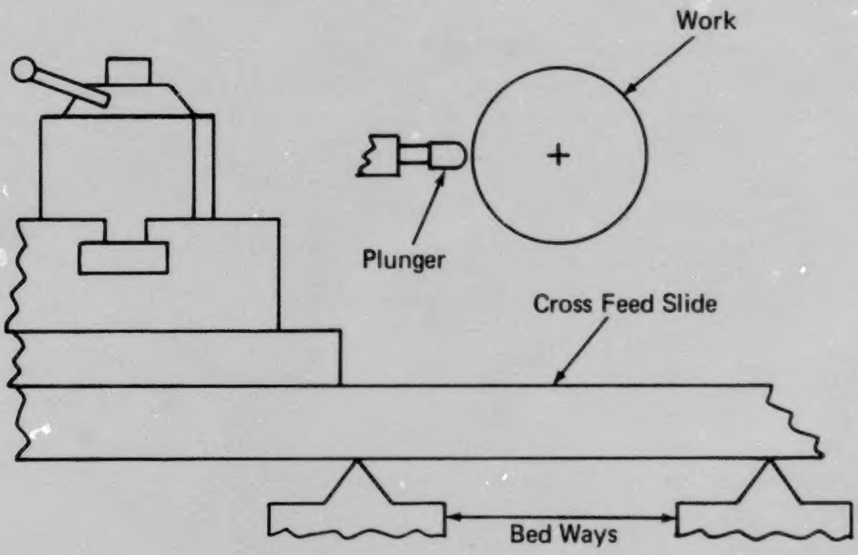

Adjusting Screw
Slide
5/8"
0
2 1 0 1 2
3°
Lockscrew
4
3
2
1
0
1
2
3
4
Taper Inch/Foot
1/4
1/8
0
1/8
1/4

JOB SHEET #15

H. Tighten lock screws and check taper with dial indicator

1. Mount dial indicator on tool post; put plunger of dial indicator on center height with plunger parallel to cross feed (Figure 116)

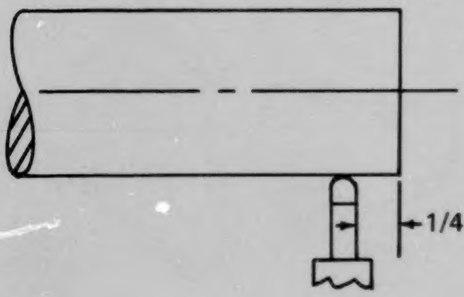
FIGURE 116



2. Position taper attachment so that carriage can travel to right, past end of work; then clamp tailstock to bed with locking screws

3. Move carriage to left until indicator plunger is about 1/4" from end of work (Figure 117)

FIGURE 117



JOB SHEET #15

4. Advance cross slide until indicator needle has moved 0.125"; move carriage by hand to left until indicator needle starts to move, then stop

5. Zero indicator dial by turning face of indicator

6. Place 2-inch spacer between carriage and carriage stop; lock carriage stop in place

   (NOTE: Travel dial, dial indicator [way-indicator], or dial of carriage can also be used to indicate when the carriage has moved 2.0" to the left.)

JOB SHEET #15

7. Move carriage to the left until carriage stop is reached; observe movement of indicator

   (NOTE: The dial indicator measures the offset of only one side of the taper. Therefore, the amount indicated would be one-half of the taper required for the distance of indicator travel--2 inches in this case. To determine the amount of taper required in the 2-inch distance, use the formula to convert taper per foot to taper per inch.)

   EXAMPLE:

$$\text{tpi} = \frac{\text{tpf}}{12}$$

$$= \frac{0.6232}{12}$$

$$= 0.0519''$$

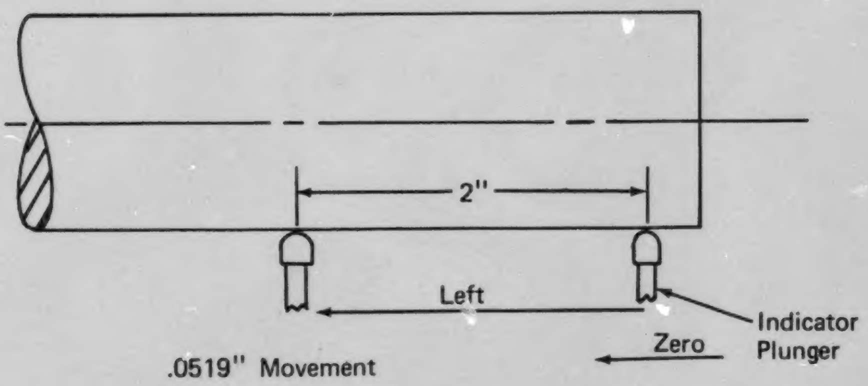
   (NOTE: The taper for the 2-inch distance would be twice the tpi [0.1038"]. Because the indicator measures only one side of the taper, the indicator movement over a 2-inch distance would be one-half of the total taper for that distance. See Figure 118.)

$$\text{Indicator Movement} = \frac{1}{2} \times \text{Taper for Distance}$$

$$= \frac{1}{2} \times 0.1038''$$

$$= 0.0519''$$

FIGURE 118



JOB SHEET #15

8. Continue adjusting taper attachment until movement of indicator is between 0.051" and 0.052"

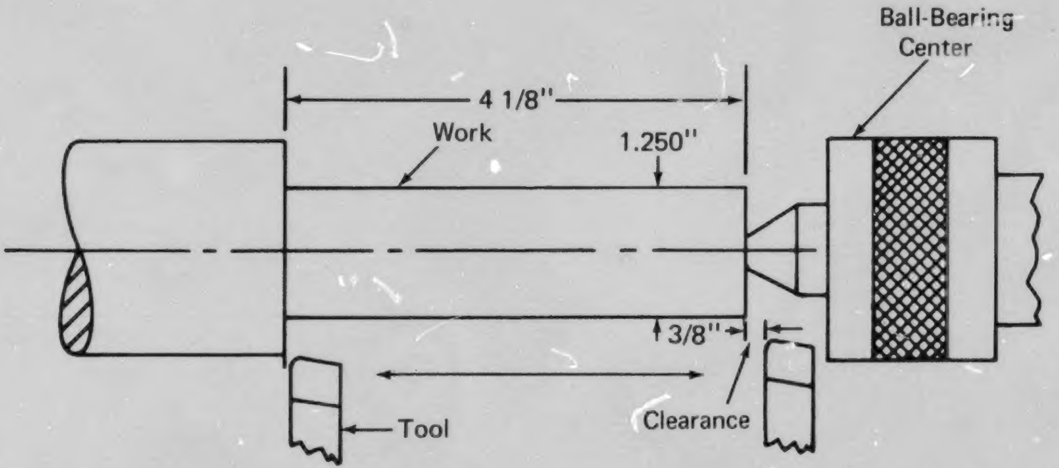
9. When taper attachment is properly adjusted, remove dial indicator

I. Set speed at 288 rpm; set feed at 0.010 ipr

J. Mount turning tool in tool post and set to center height

K. Check to make sure that carriage moves to left so that tool will cut to shoulder; move carriage to right to make sure that tool clears work about 3/8" to 1/2" (Figure 119)

FIGURE 119



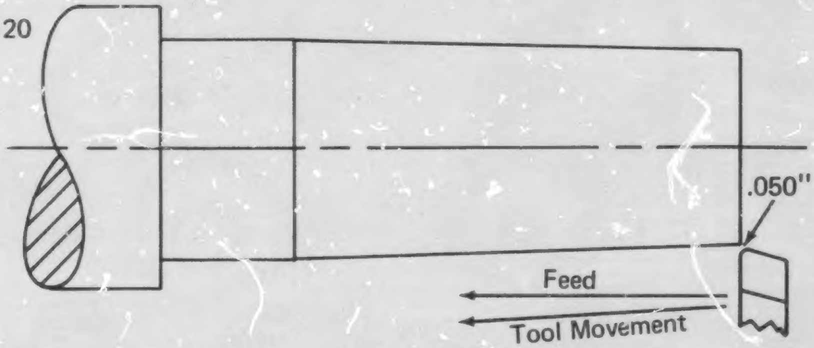
L. Move tool back to left so that it is about 1/4" from end

M. Turn on lathe and start spindle; advance tool until it starts to shave work; stop and zero cross feed

JOB SHEET #15

N. Move carriage to right to clear tool and advance the cross feed to move tool in to a depth of 0.050"; engage carriage power feed and allow tool to cut until it stops cutting; apply cutting oil as required during cutting (Figure 120)

FIGURE 120



O. Stop power feed, and move carriage to right until tool clears end of work; advance tool another 0.015"

P. Increase speed to 400 rpm, decrease feed to 0.005 ipr, and make another cut; then move tool right to clear work

Q. Stop machine, remove work from centers, and apply a thin coat of Prussian blue

R. Slide work into #4 plug gauge or #4 taper of lathe tailstock; rotate with hand and remove

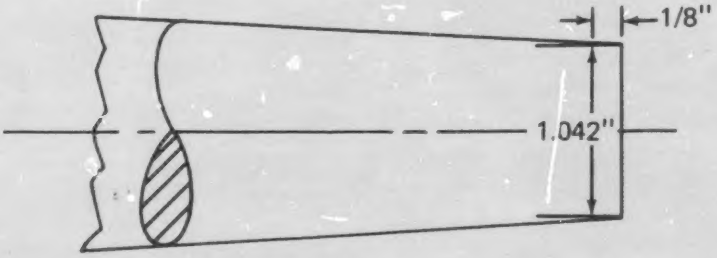
(NOTE: If taper is set correctly, rotation should mark the circumference of the taper along its full length.)

S. Make any necessary adjustments

T. Put work back between centers, measure at 1/8" from small end of taper with micrometer

(NOTE: Measurement of small end at 1/8" from end should be 1.042" ± 0.001". See Figure 121.)

FIGURE 121



JOB SHEET #15

U. Determine amount to be removed, advance tool as required, and make finish cut

V. Stop spindle, check taper, and cut again if required

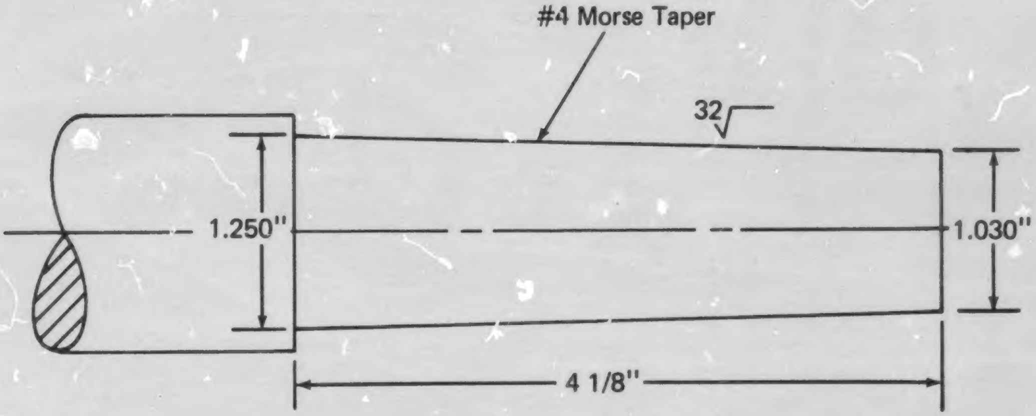
W. Clean machine and put away all tools

X. Complete evaluation sheet on following page

Y. Turn in part and evaluation sheet to instructor

JOB SHEET #15--EVALUATION SHEET

NAME ______________________________ SCORE ______________


#4 Morse Taper
32
1.250"
1.030"
4 1/8"

	In Tolerance	Out of Tolerance
Length of taper 4 1/8" + 1/64" - 0.0"		
Large diameter 1.250" ± 0.002"		
Small diameter 1.030" ± 0.002"		
Finish #32		

Remarks ____

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ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #16--TURN A TAPER WITH COMPOUND

I. Equipment and materials

   A. Right-hand turning tool

   B. Facing tool

   C. Steel rule, 6"

   D. Lathe with chuck

   E. Quick-change tool post and toolholders

   F. Wrenches for chuck, tool post, toolholder, and compound

   G. Cutting oil

   H. Hex steel bar, SAE 1018, 1 1/8" diameter, 4 1/8" long

   (NOTE: A 1 1/8" round steel bar may be substituted.)

   I. Clean shop cloth

II. Procedure

   A. Check oil levels and perform daily maintenance

   B. Chuck work with about 2" protruding from end of chuck jaw

   C. Face end smooth

   D. Set speed at 425 rpm

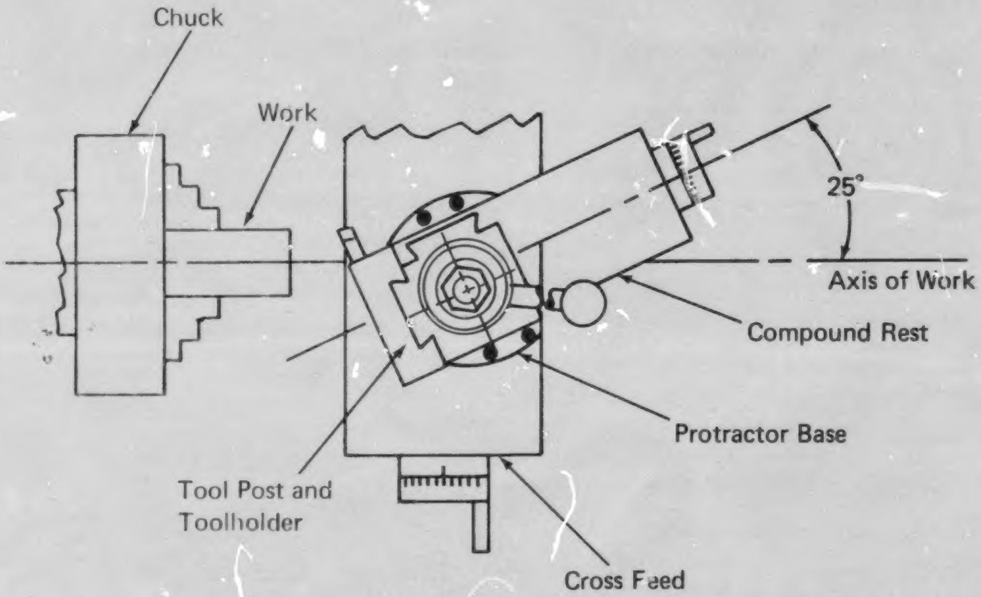
JOB SHEET #16

E. Loosen compound rest lock nuts and set compound at a 25° angle to axis of work (Figure 122)

(CAUTION: When cutting angles [tapers] with the compound, it is recommended to cut toward chuck; this keeps your hand away from revolving chuck.)

(NOTE: Depending on the zero reference of the protractor base of the compound, the reading will be 25° or 65°.)

FIGURE 122

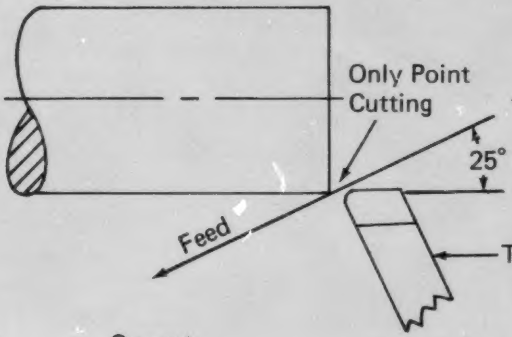

Chuck
Work
25°
Axis of Work
Compound Rest
Protractor Base
Tool Post and Toolholder
Cross Feed

F. Set tool to center height

JOB SHEET #16

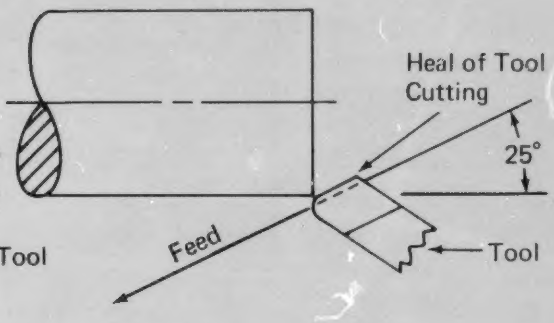
G. Position tool so that only the point makes contact with work when tool is fed along the angular setting of compound; place tool near end of work (Figures 123 and 124)

FIGURE 123



Correct

FIGURE 124



Incorrect

H. Lock tool post and toolholder in place

I. Turn on lathe and start spindle

J. Apply cutting oil as required during cutting; advance tool 0.150" with the cross feed; feed tool into work, using compound handwheel with a slow, continuous motion until tool stops cutting

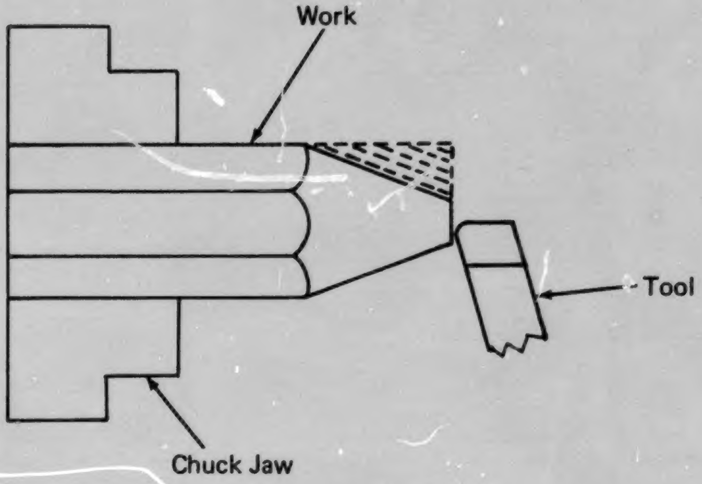
K. Crank tool back with same motion until it clears work

(NOTE: Turning the compound with both hands in a continuous motion gives a smooth finish without feed marks because there is pressure on tool at all times.)

JOB SHEET #16

L. Continue this process until the work comes to a point (Figure 125)

FIGURE 125



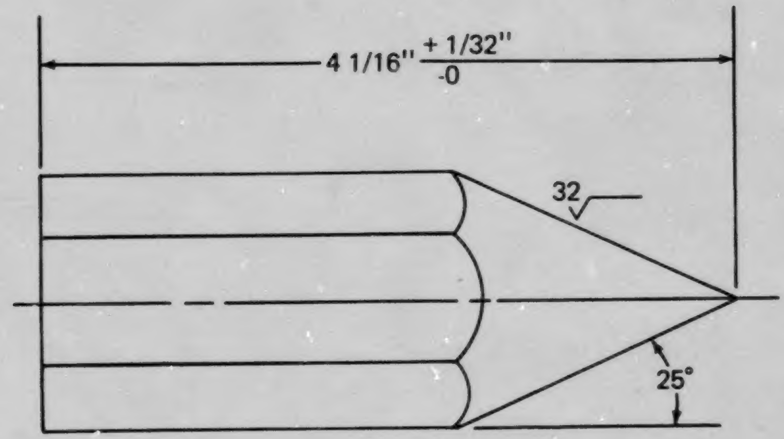
M. Clean machine and put away all tools

N. Complete evaluation sheet on following page

O. Turn in work and evaluation sheet to instructor

JOB SHEET #16–EVALUATION SHEET

NAME ______________________ SCORE ____________



	In Tolerance	Out of Tolerance
Measurement of angle 25° ± 30'		
Measurement of overall length 4 1/16" + 1/32 - 0.0		
Finish of machined surface, #32		

Remarks ______________________

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #17--PERFORM BORING OPERATIONS

I. Equipment and materials

- A. Lathe with chuck, tailstock center, and carriage stop
- B. Tool post with 3/4" boring bar holder and toolholder
- C. Boring bar or tool bit ground for boring
- D. Steel rule, 6"
- E. Cutting oil
- F. Drill chuck with arbor to fit tailstock
- G. Right-hand facing tool
- H. Combination drill and countersink, #4
- I. Drill, 5/16"
- J. Drill, 15/16"
- K. Set of telescoping gauges
- L. Micrometer, 1" to 2"
- M. Depth micrometer, 0" to 1"
- N. Steel bar, SAE 1020, 2" diameter, 2 1/4" long
- O. Wrenches for chuck, compound, toolholder, boring bar, and drill chuck
- P. Clean chop cloth

II. Procedure

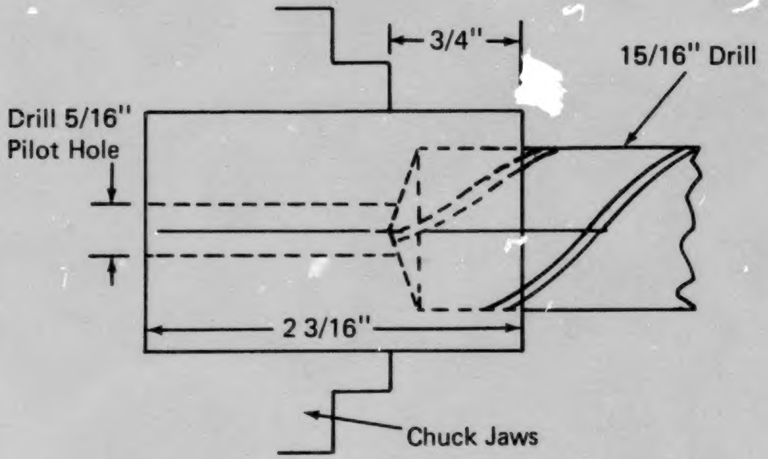
- A. Check all oil levels and perform daily maintenance
- B. Bore a hole to size
    1. Chuck work with about 3/4" protruding past chuck jaws
    2. Face end smooth
    3. Center drill and drill 5/16" pilot hole through work

       (NOTE: It is recommended that a pilot hole be drilled for drills 3/4" in diameter or larger. The pilot drill size should be about 1/32" larger than the web of the drill size.)

JOB SHEET #17

4. Drill 15/16" hole through work (Figure 126)

FIGURE 126

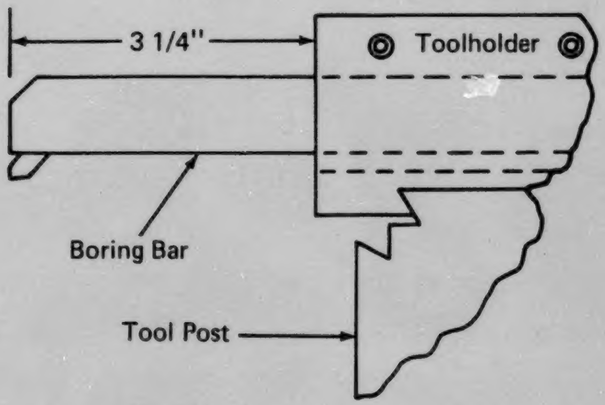

3/4"
15/16" Drill
Drill 5/16" Pilot Hole
2 3/16"
Chuck Jaws

5. Mount boring bar in toolholder with a maximum of 3 1/4" of bar extending from the toolholder (Figure 127)

(NOTE: To eliminate spring and chattering, the boring bar should always be as short as possible.)

(CAUTION: Care must be taken when setting up for boring to make sure the chuck does not strike compound.)

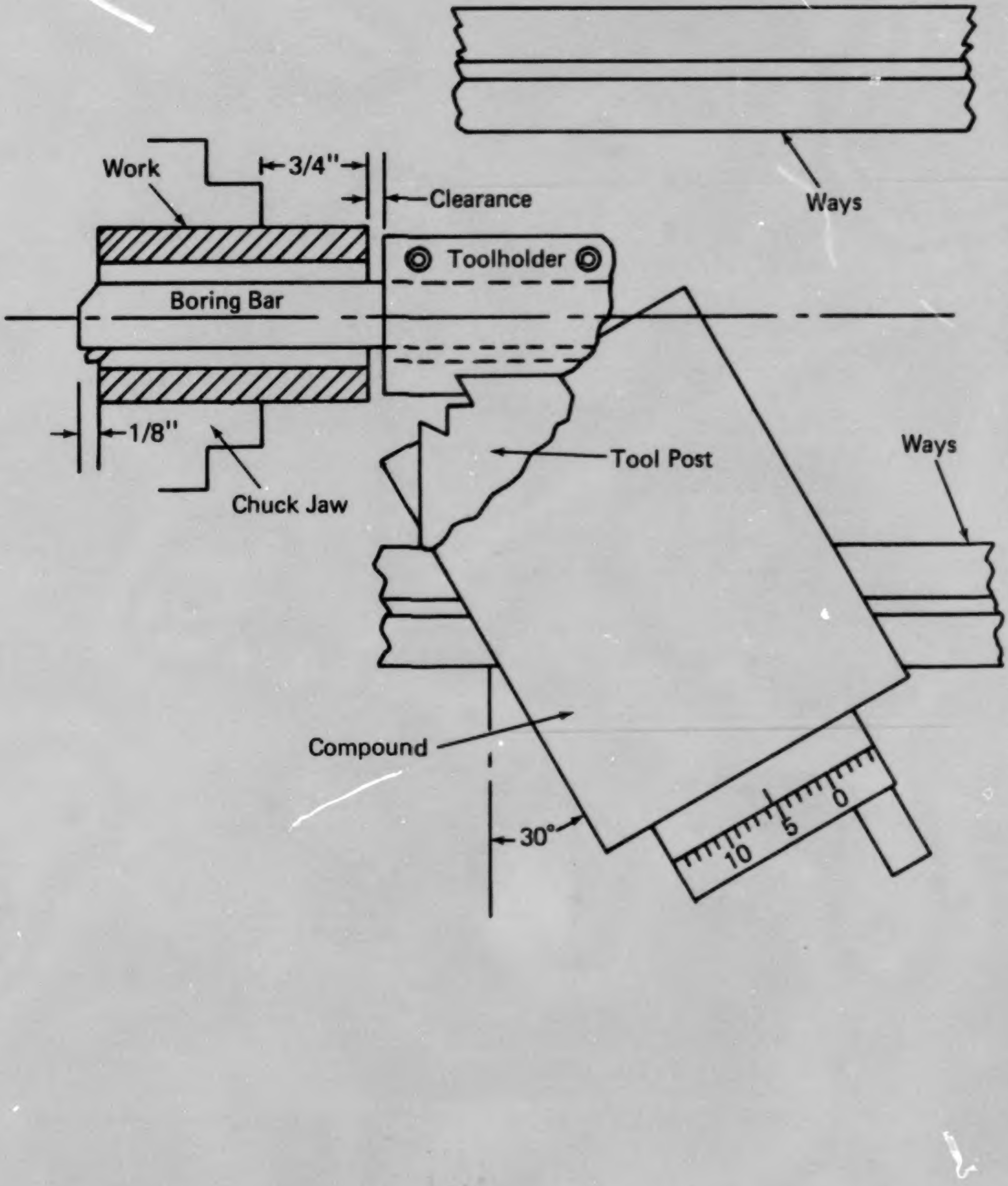
FIGURE 127


3 1/4"
Toolholder
Boring Bar
Tool Post

JOB SHEET #17

6. Set compound 30° to right of cross feed and align boring bar parallel to the ways; then check to see if boring bar will clear through work; set carriage stop to allow cutting tool to clear hole about 1/8" (Figure 128)

Figure 128



Work
3/4"
Clearance
Ways
Toolholder
Boring Bar
1/8"
Chuck Jaw
Tool Post
Ways
Compound
30°
10
5
0

JOB SHEET #17

7. Set speed at 512 rpm with a feed of 0.007 ipr (roughing is 0.050" depth)

EXAMPLE: $$\text{rpm} = \frac{4 \times \text{CS}}{\text{Diameter of Bore}} = \frac{4 \times 120}{0.938} = 512 \text{ rpm}$$

8. Engage power feed and rough bore to 1.380", applying cutting oil as required during boring

9. Set speed at 362 rpm with a feed of 0.005 ipr, and make a 0.010" finish cut for measuring

10. Use telescoping gauges to measure bore

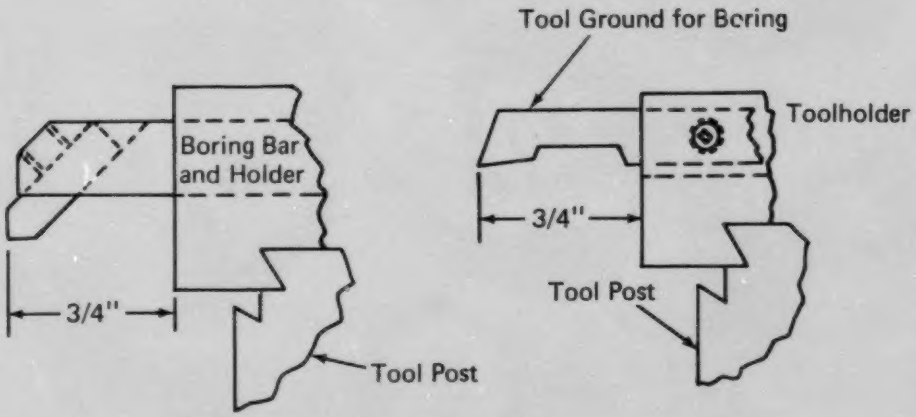
11. Subtract bore measurement from 1.409 to determine amount remaining to be removed

12. Advance tool to remove required amount; measure and rebore as necessary to a diameter of $1.409"\ {}^{+0.010"}_{-0.0"}$

C. Bore a shoulder

1. Bore a shoulder 1 3/4" x 3/8" deep, using same boring bar or a tool ground from high-speed steel (Figure 129)

FIGURE 129


Boring Bar and Holder
3/4"
Tool Post
Tool Ground for Boring
Toolholder
3/4"
Tool Post

Top View

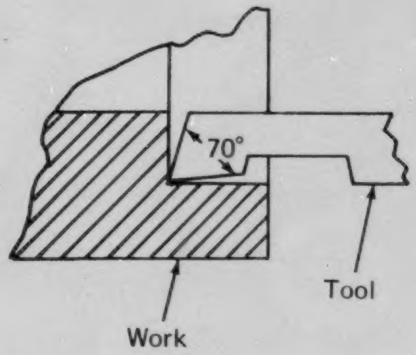
JOB SHEET #17

2. Align compound parallel to axis of work

3. Position tool so that there is clearance at end and at cutting edge (Figure 130)

   (NOTE: The tool is ground to an angle of less than 90° so that bore and shoulder can be squared.)

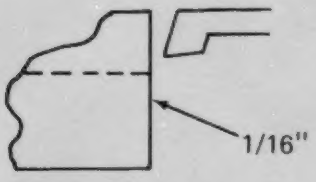
FIGURE 130



4. Set rpm at 341 and feed rate at 0.010 ipr

5. Position tool slightly outside bore about 1/16" from end of work (Figure 131)

FIGURE 131



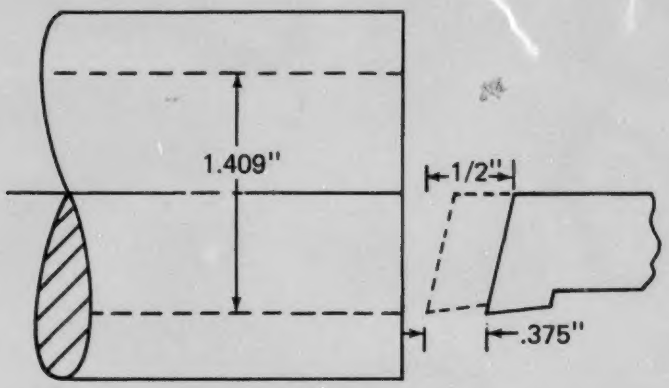
Top View

6. Move carriage stop up to carriage and lock in place; start spindle; advance compound until tool just starts to cut on end of work, and then zero the collar of the compound

JOB SHEET #17

7. Move carriage to right about 1/2" and advance compound to move tool 0.375"; crank the cross feed in so that tool will not cut if it moves into bore (Figure 132)

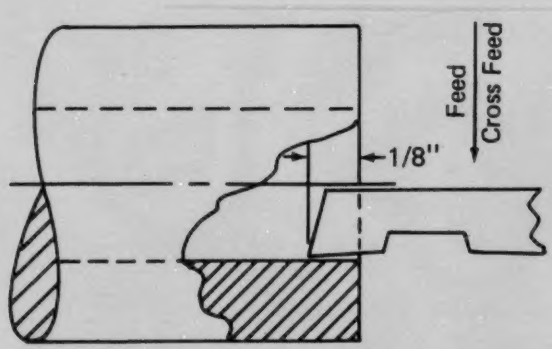
FIGURE 132



Top View

8. Move carriage to left until tool is inside hole 1/8"; slowly crank cross feed counterclockwise until tool shaves wall of bore (Figure 133)

FIGURE 133

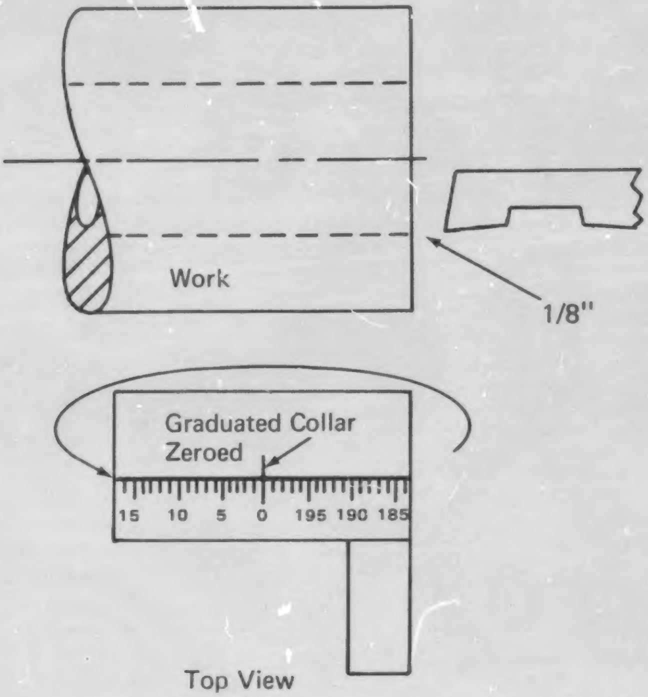


Top View

JOB SHEET #17

9. Move carriage to right until tool is clear of work 1/8"; zero collar on cross feed (Figure 134)

FIGURE 134



10. Turn cross feed counterclockwise and move tool so that a cut of 0.050" can be made

11. Engage power feed and make a cut, allowing carriage to make contact with carriage stop; apply cutting oil as required during boring

    (NOTE: A cut of 0.050" will enlarge the bore 0.100". Do not crank cross feed in each time tool is cleared for next cut.)

12. Continue to take cuts of 0.050" until bore is 1.709" (three cuts of 0.050"); decrease speed to 293 rpm and make a 0.010" cut at a feed rate of 0.005 ipr

JOB SHEET #17

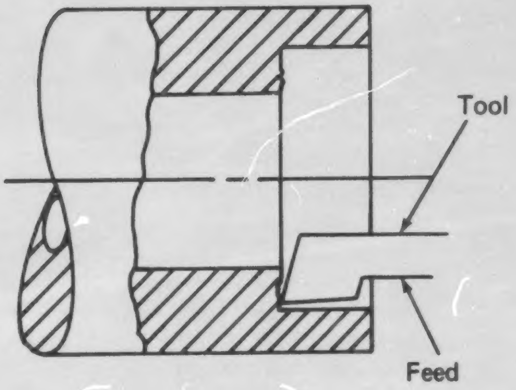
13. Stop spindle; use telescoping gauge to gauge bore and measure with a micrometer; subtract measurement from 1.750" to obtain amount required to be removed for correct diameter

14. Continue to machine by making cuts of 0.010" or less until bore is to size

15. When bore is to size, the shoulder will not be smooth, so hold carriage on carriage stop with one hand and crank cross feed into center of bore until tool quits cutting; then clear tool from bore and stop spindle (Figure 135)

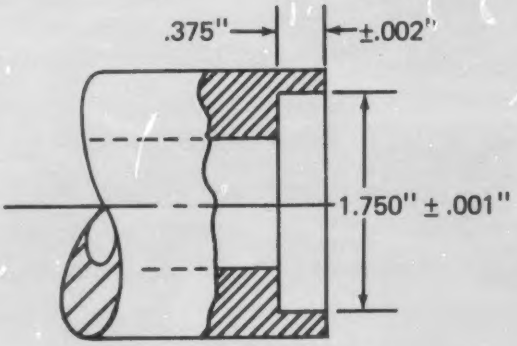
    (NOTE: Before moving cross feed in, note setting of graduated collar; in case you need to open bore up more, you will know where tool was for last cut.)

FIGURE 135



16. Measure work and cut as necessary to obtain correct dimensions (Figure 136)

FIGURE 136



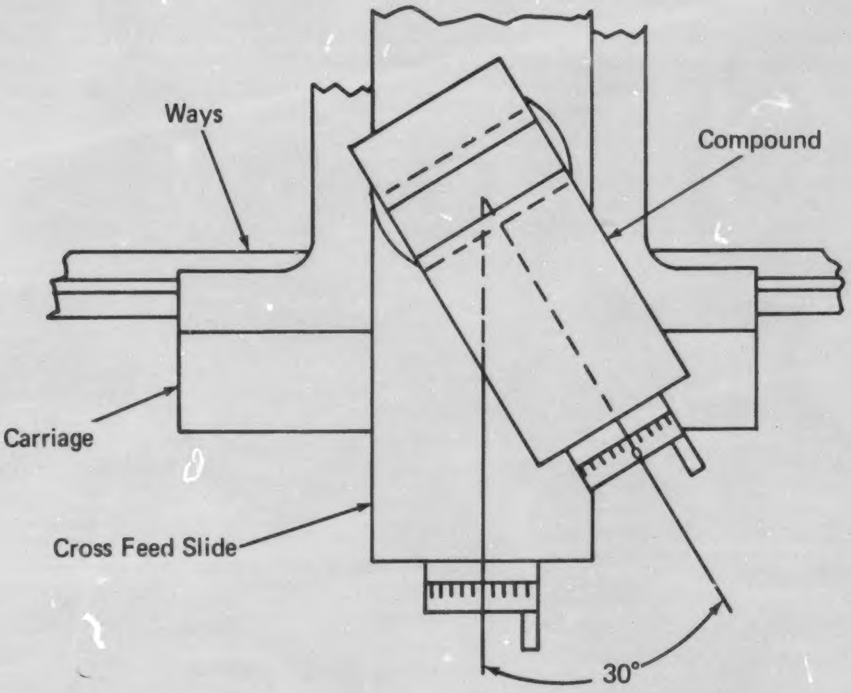
JOB SHEET #17

D. Remove work from chuck and turn end-for-end; rechuck

E. Bore a taper (angular boring)

1. Face end of part smooth
2. Set compound 30° to right of cross feed slide (Figure 137)

FIGURE 137

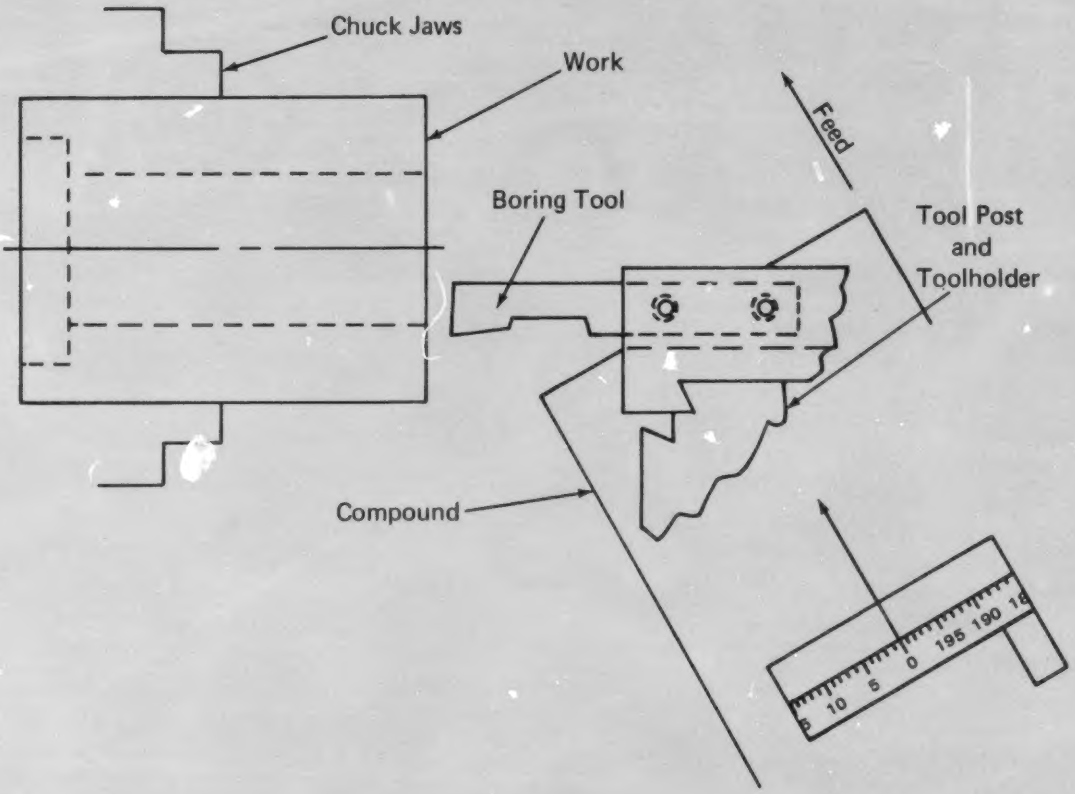

Ways
Compound
Carriage
Cross Feed Slide
30°

JOB SHEET #17

3. Set tool to center height

4. Position tool post so that cutting edge of tool has proper clearance to cut end of bore at the 30° angle of feed (Figure 138)

FIGURE 138


Chuck Jaws
Work
Feed
Boring Tool
Tool Post and Toolholder
Compound
5
10
5
0
195
190
18

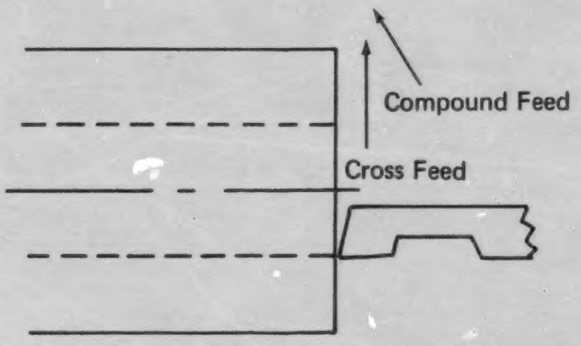
5. Set speed at 340 rpm and start spindle

6. Move carriage to position tool 1/16" from end of work

JOB SHEET #17

7. Advance tool with compound until it just starts to cut end of work; then move tool in to edge of bore with cross feed (Figure 139)

FIGURE 139

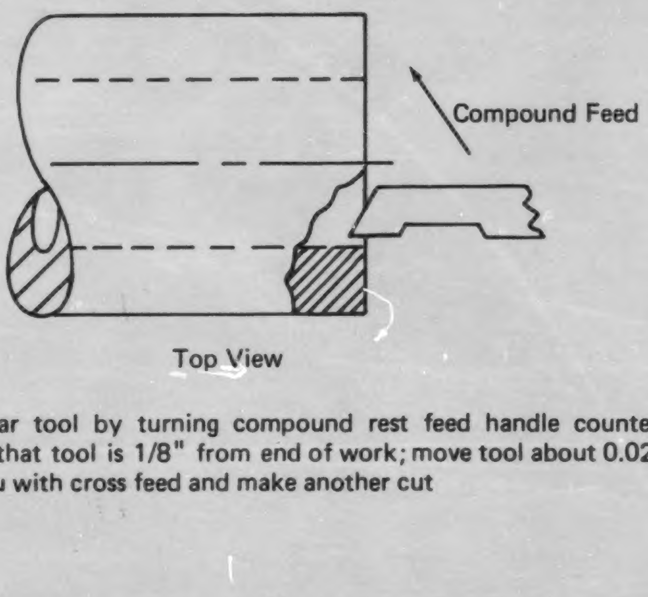


Top View

8. Turn compound rest feed handle counterclockwise to move tool 1/8" from end; turn cross feed counterclockwise to move tool 0.100" toward you

9. Applying cutting oil as required during cutting, advance tool with compound, feeding compound continuously until tool stops cutting (Figure 140)

FIGURE 140



Top View

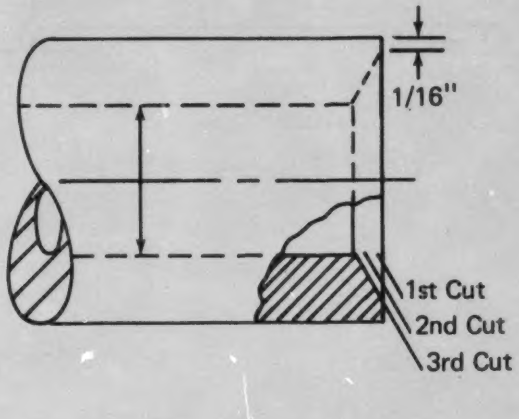
10. Clear tool by turning compound rest feed handle counterclockwise so that tool is 1/8" from end of work; move tool about 0.020" toward you with cross feed and make another cut

JOB SHEET #17

11. Stopping occasionally to check the work, continue this process until 1/16" of faced area is left on end (Figure 141)

    (NOTE: Large diameter of taper will measure 1 7/8".)

FIGURE 141



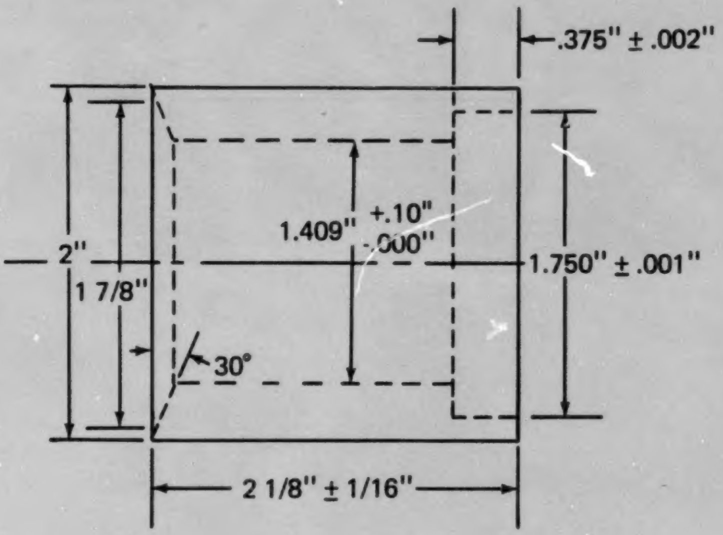
F. Turn off power, clean machine, and put away all tools

G. Complete evaluation sheet on following page

H. Turn in work and evaluation sheet to instructor

JOB SHEET #17--EVALUATION SHEET

NAME ______________________________ SCORE ______________


.375" ± .002"
2"
1 7/8"
1.409" +.10" -.000"
1.750" ± .001"
30°
2 1/8" ± 1/16"

	In Tolerance	Out of Tolerance
Diameter of 1.409" bore		
Diameter of counter bore		
Depth of counter bore		
Angle of taper ± 30°		
Diameter of large end		
Overall length		

Remarks ____

____

____

____

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #18--CUT EXTERNAL THREADS TO A RELIEF

I. Equipment and materials

- A. Right-hand threading tool
- B. Center gauge
- C. Steel rule, 6"
- D. Lathe with chuck and tailstock center
- E. Quick-change tool post and toolholders
- F. Screw pitch gauge
- G. Cutting oil
- H. Steel bar, SAE 1018, 2 1/2" diameter, 4" long

  (NOTE: This material was used in Job Sheets #2-#8.)
- I. Wrenches for chuck, tool post and toolholders, and compound
- J. Clean shop cloth
- K. File

II. Procedure

- A. Check all oil levels and perform daily maintenance
- B. Chuck on 2" diameter of work
- C. Set compound 30° to right of cross feed

  (NOTE: If cutting left-hand threads, the compound would be set 30° left of cross feed.)
- D. Set lathe speed at 80 rpm
- E. Mount tool in toolholder and adjust to center height

  (NOTE: Threading is done at one-fourth of turning speed.)

  EXAMPLE:

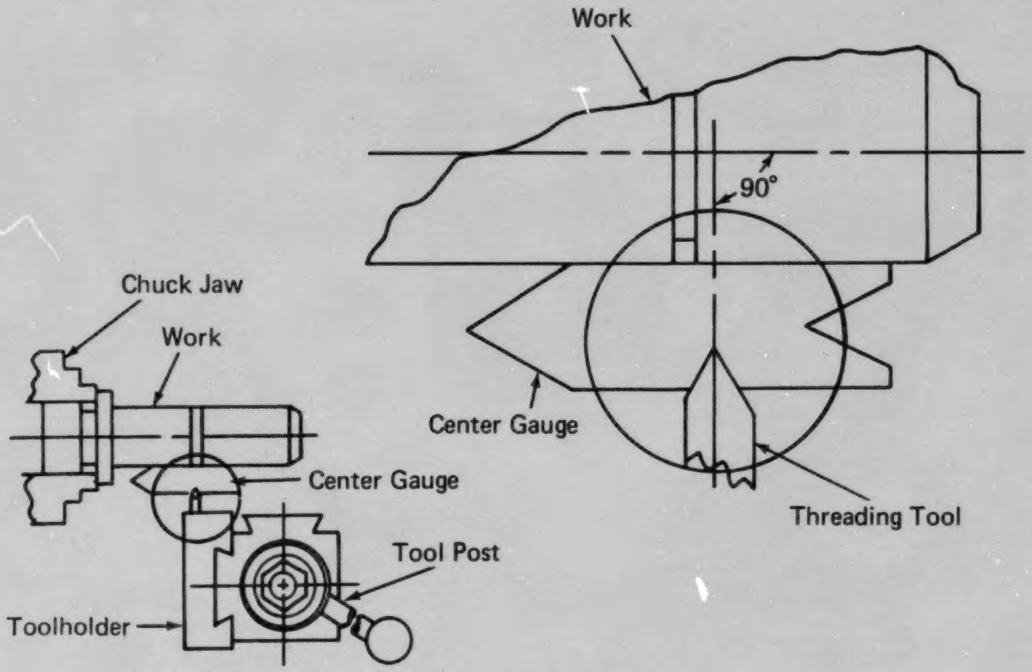
$$\begin{aligned}\text{Thread Speed} &= 1/4\left[\frac{4 \times CS}{\text{Diameter}}\right]\\ &= 1/4\left[\frac{4 \times 120}{1.5}\right]\\ &= 1/4\,[320]\\ &= 80 \text{ rpm}\end{aligned}$$

JOB SHEET #18

F. Loosen tool post and set tool square to axis of threads using center gauge (Figure 142)

(NOTE: When aligning the tool, hold center gauge parallel to center line of work and tap the tool post until tool fits V-groove in center gauge.)

FIGURE 142



G. Set carriage controls to cut twelve threads per inch

(NOTE: The location of these controls varies with brands of machines; consult the operator's manual or have the instructor show you which controls must be set to cut threads.)

H. Advance threading tool with cross feed until point of tool is close to work and cross feed handwheel handle is at eleven o'clock position; zero the graduated collar

I. Start spindle and advance compound feed handwheel until cutting tool marks the work; move carriage so that tool is just to right of work

J. Zero graduated collar of compound

JOB SHEET #18

K. Calculate compound depth of feed for twelve threads per inch when using compound feed

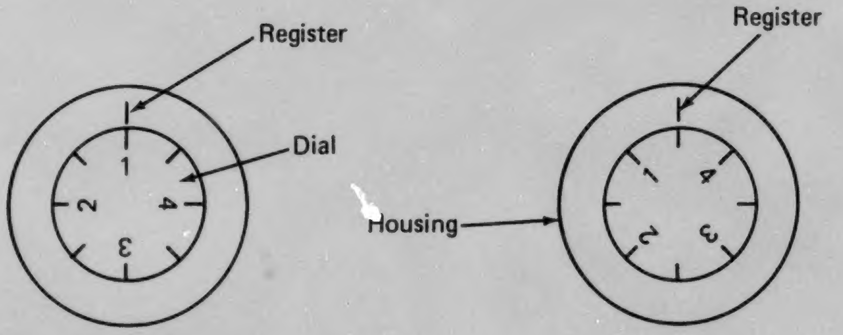
(NOTE: Compound depth of feed is equal to 0.75 divided by the number of threads per inch.)

EXAMPLE:
$$C = \frac{0.75}{N}$$
$$= \frac{0.75}{12}$$
$$= 0.0625''$$

L. Advance compound 0.003" and set half-nut lever to one of the lines on thread-chasing dial (Figure 143)

(NOTE: For even numbers of threads, the half nut may be engaged on numbered or unnumbered lines; for odd numbers of threads, the half-nut lever must be engaged on numbered lines only. The same line or number does not need to be used each time a cut is made.)

FIGURE 143



Numbered Lines
1, 2, 3, & 4

Unnumbered Lines
1 1/2, 2 1/2, 3 1/2, & 4 1/2

M. Engage half-nut lever and apply cutting oil; allow carriage to move with lead screw until tool reaches recess

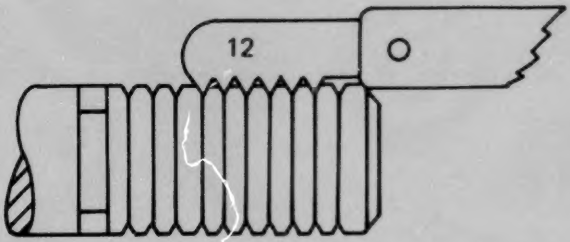
N. Disengage half-nut lever and crank cross feed to move tool away from work

O. Move carriage to right until tool clears end of work; turn cross feed back to zero (original position)

JOB SHEET #18

P. Stop spindle, and use a screw pitch gauge or a center gauge to check for the correct pitch (Figure 144)

FIGURE 144



Q. Make any necessary adjustments

R. Start spindle, and set depth of cut by advancing compound feed for the first cut; apply cutting oil

(NOTE: Amount of feed for each cut should be less than previous cut. Plan to make about six to seven cuts. To clean the threads, two cuts are made without advancing the tool.)

EXAMPLE: 0.062" = Total amount of feed of compound
0.003" Trial cut
0.025" First cut
0.015" Second cut
0.010" Third cut
Same setting (no advancement) Fourth cut
0.006" Fifth cut
0.003" Sixth cut
Same setting as sixth cut = Seventh cut

S. Engage half-nut lever and allow tool to move to recess

T. Disengage half-nut lever, crank cross feed out of work until tool is clear, and move carriage to right until tool is past end

U. Crank cross feed in to zero and advance tool for next cut

V. Apply cutting oil and repeat cutting steps until total depth of feed is reached

W. File burrs from top of thread and stop spindle

X. Use a test nut or other means to check size of threads

(NOTE: If threads are to be cut to a particular class of fit, it is necessary to check the pitch diameter with a pitch micrometer or three-wires before making the finish cuts.)

JOB SHEET #18

Y. Turn part end-for-end and rechuck

Z. Repeat steps H through Y to cut sixteen threads per inch to other recess

(CAUTION: Care must be taken when cutting to a shoulder: If tool hits shoulder, it damages tool and work, and changes angle of tool.)

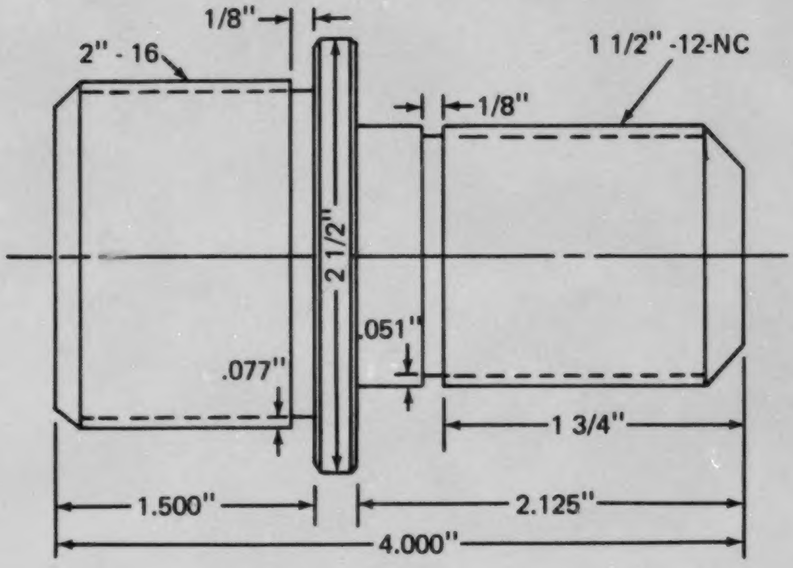
AA. Turn power off, clean machine, and put away all tools

BB. Complete evaluation sheet on following page

CC. Turn in work and evaluation to instructor

JOB SHEET #18--EVALUATION SHEET

NAME ______________________________ SCORE ______________


1/8"
2" - 16
1 1/2" -12-NC
1/8"
2 1/2"
.051"
.077"
1 3/4"
1.500"
2.125"
4.000"

	In Tolerance	Out of Tolerance
Smoothness of 1 1/2" 12-thread		
Nut fits threads		
Threads cut to recess		
Smoothness of 2" 16-thread		
Nut fits threads		
Threads cut to recess		

Remarks ____

____

____

____

____

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #19--PICK UP THREADS

I. Equipment and materials

A. Right-hand threading tool

B. Center gauge

C. Steel rule, 6"

D. Lathe with four-jaw chuck

E. Quick-change tool post and toolholder

F. Threaded stud, 1.0", 8NC3A

II. Procedure

(NOTE: This procedure may be required on a bolt that has damaged threads, or when a threading tool is removed, sharpened, and put back in toolholder.)

A. Check all oil levels and perform daily maintenance

B. Set compound 30° to right of cross feed

C. Set lathe speed

D. Chuck bolt and align

E. Mount threading tool in toolholder, adjust center height, and use center gauge to square tool to axis of bolt

F. Set carriage controls to cut eight threads per inch

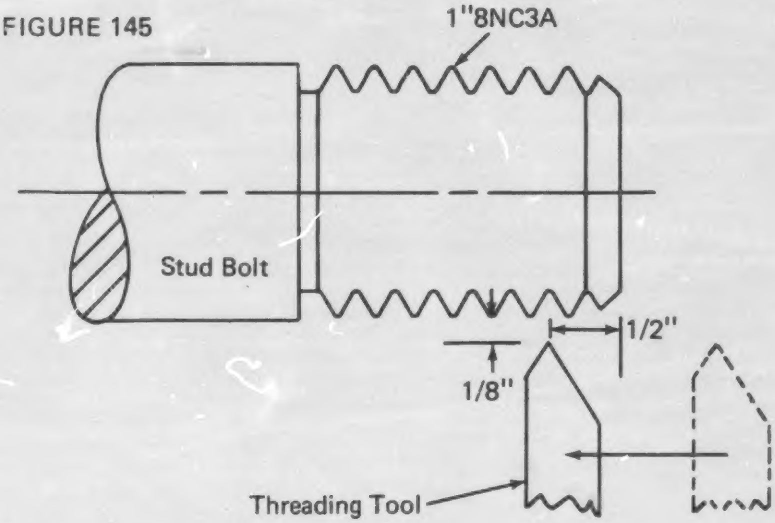
G. Move carriage to right so that tool clears end of bolt 1/8" from work

JOB SHEET #19

H. Start spindle and engage half-nut lever; allow tool to travel to left until it is about 1/2" to the left of end of bolt; stop spindle (Figure 145)

(NOTE: Do not disengage the half-nut lever yet.)

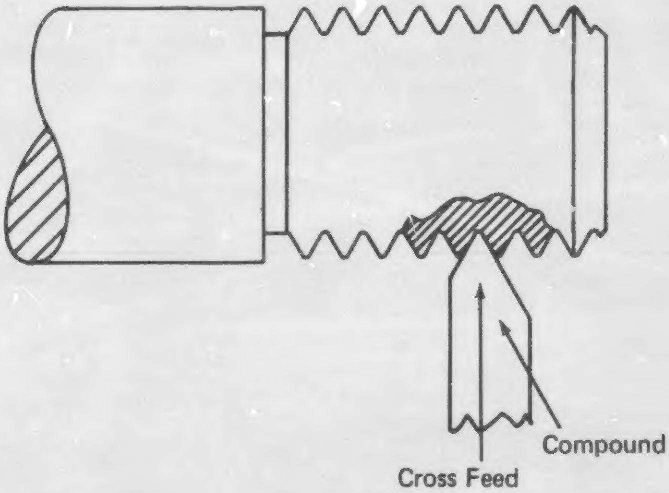
FIGURE 145


1"8NC3A
Stud Bolt
1/2"
1/8"
Threading Tool

I. Advance tool by moving cross feed and compound until tool fits in V-groove of thread (Figure 146)

(NOTE: When picking up threads, you may want place a piece of paper between the bed and work to help reflect light.)

FIGURE 146


Compound
Cross Feed

JOB SHEET #19

J. Zero both graduated collars and back tool out of threads with cross feed; disengage half-nut lever

K. Move tool to right with carriage handwheel until tool clears end of work about 1/4"; turn cross feed to zero

L. Start spindle, engage half-nut lever, and allow tool to move through threads to recess; disengage half-nut and clear tool

M. Stop spindle and check with test nut; if necessary, make one or more cuts after feeding compound 0.001"; check with test nut each time

N. Have instructor check procedure

O. Clean machine and put away tools

ENGINE LATHE OPERATIONS
UNIT III

JOB SHEET #20–CUT INTERNAL THREADS

I. Equipment and materials

A. Lathe with four-jaw chuck

B. Quick-change tool post and boring bar holder

C. Boring bar, 3/4", with threading tool

D. Center gauge

E. Steel rule, 6"

F. Cutting oil

G. Thread plug gauge or test bolt

H. Steel bar, 2" diameter, 2 1/4" long

(NOTE: This is the same work produced in Job Sheet #16.)

I. Dial test indicator and holder

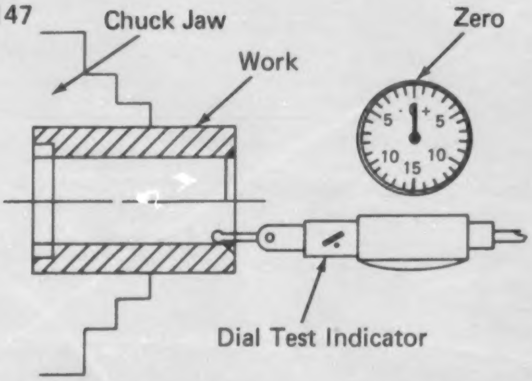
II. Procedure

A. Check oil levels and perform daily maintenance

B. Chuck part in four-jaw chuck, and align bore in chuck with dial indicator (Figure 147)

(NOTE: The tapered portion faces out to provide for easy entry of threading tool.)

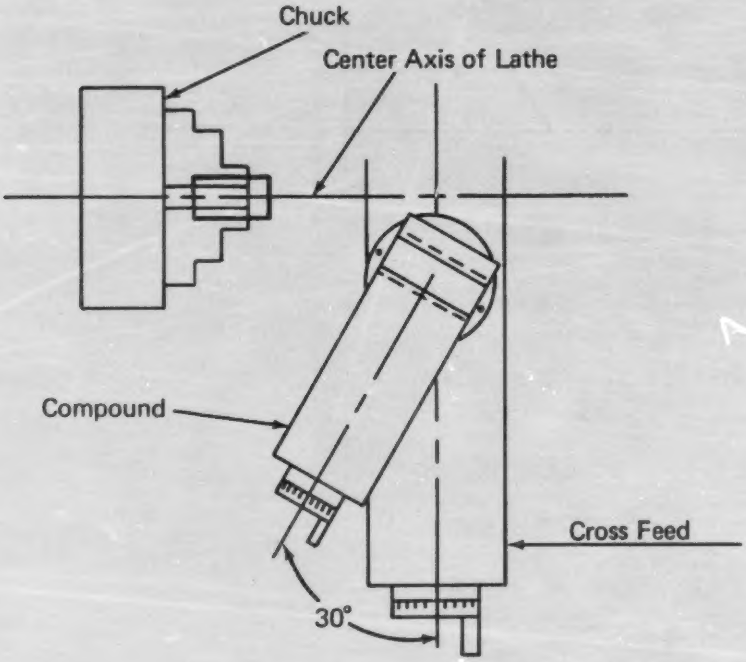
FIGURE 147



JOB SHEET #20

C. Set compound 30° to left of the cross feed (Figure 148)

FIGURE 148


Chuck
Center Axis of Lathe
Compound
Cross Feed
30°

D. Mount boring bar on tool post and set to center height

JOB SHEET #20

E. Use center gauge to align threading tool parallel to axis of bore (Figures 149 and 150)

FIGURE 149

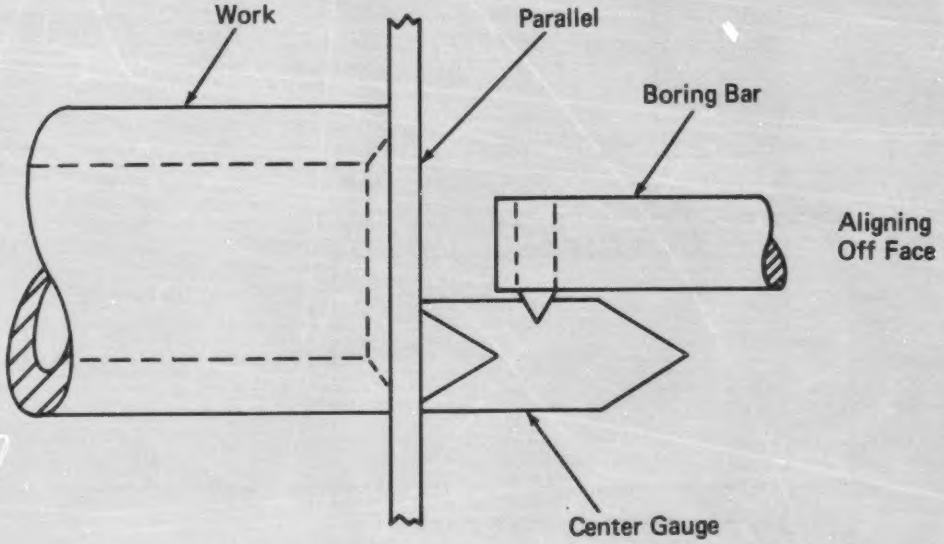
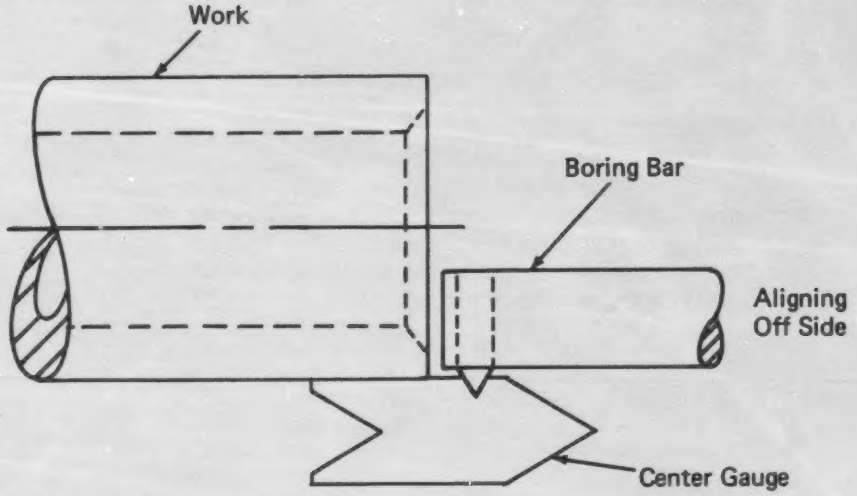

Work
Parallel
Boring Bar
Aligning
Off Face
Center Gauge

FIGURE 150


Work
Boring Bar
Aligning
Off Side
Center Gauge

F. Set speed at 85 rpm

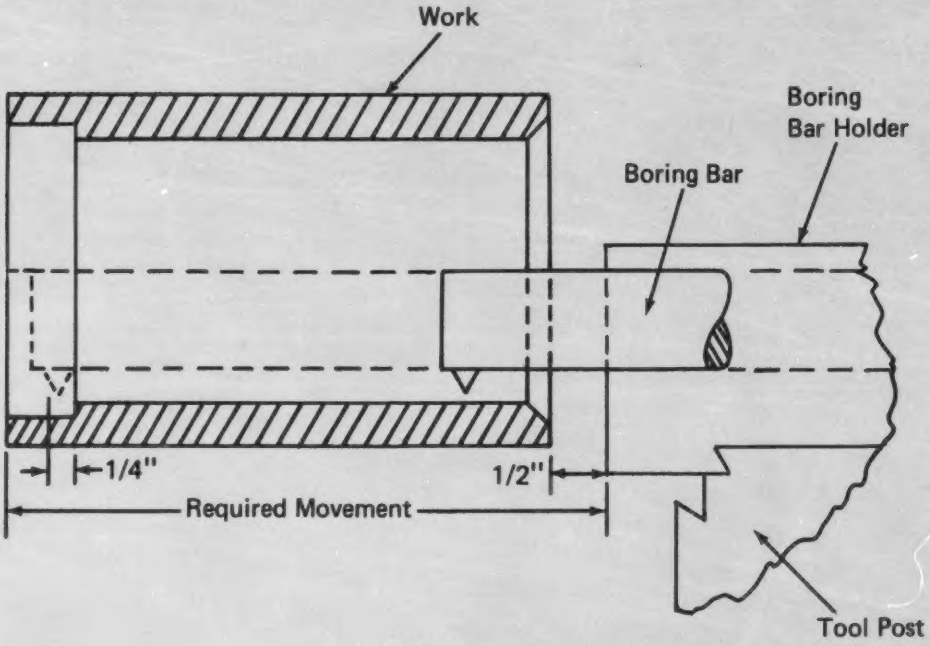
G. Set carriage to cut twelve threads per inch

JOB SHEET #20

H. Advance cross feed until boring bar clears bore; then move carriage to left to check for bar clearance and extension

(NOTE: The extension of the boring bar should be minimal to prevent spring. However, travel of the carriage must permit the boring bar to move 1/4" beyond the thread and still allow 1/2" clearance between the work and the toolholder [Figure 151].)

FIGURE 151


Work
Boring Bar Holder
Boring Bar
1/4"
1/2"
Required Movement
Tool Post

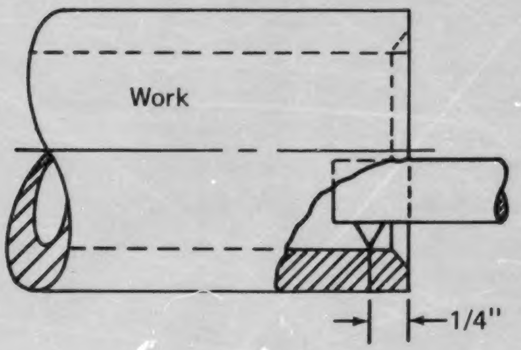
I. Move carriage to right until point of threading tool is 1/4" inside bore

J. Start spindle, turn compound rest feed counterclockwise to remove any slack in screw, and set graduated collar

JOB SHEET #20

K. Crank cross feed counterclockwise until tool just starts to cut on bore; zero graduated collar of cross feed (Figure 152)

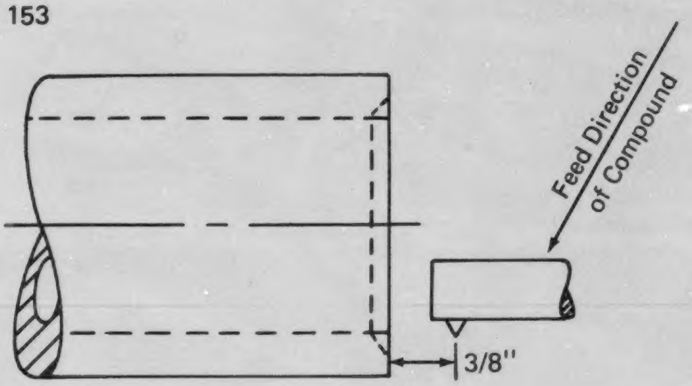
FIGURE 152



L. Move carriage to right until boring bar clears end of work 3/8"; then crank compound rest feed counterclockwise to feed tool 0.020" (Figure 153)

(NOTE: Most graduated collars on compounds are graduated 1:1 [amount moved equals amount of tool movement]; because you are turning counterclockwise, the reading should be on 80 if 100 equals one revolution of graduated collar.)

FIGURE 153



M. Put a drop of cutting oil in bore, engage half-nut lever and allow tool to move to left until point of tool clears left end of work

JOB SHEET #20

N. Disengage half nut, crank cross feed clockwise about one revolution, move carriage to right until tool clears end, and crank cross feed to zero setting

O. Repeat steps L through N to produce second cut

P. To clean threads, repeat steps M and N to produce cut without feed

(NOTE: The cut produced during this step is due to the spring of the boring bar.)

Q. Advance tool 0.010" and repeat steps M and N

R. To clean threads, repeat steps M and N without advancing tool

S. Repeat steps L through N to make three cuts with depths of 0.005", 0.002", and 0.002", and one or two cuts with no advancement

(NOTE: The compound feed for twelve threads per inch is 0.063 [0.75/N]. Following these steps, you will have fed the compound 0.059".)

T. Stop machine and clean threads; check threads with test bolt or thread plug gauge 1 1/2-12 NF

(NOTE: The test bolt was cut in Job Sheet #18.)

U. Continue to make cuts of 0.001" until bolt or gauge screws in properly

(NOTE: If last cuts are made too heavily, thread diameter will be tapered; this can be corrected by making cuts without advancing compound.)

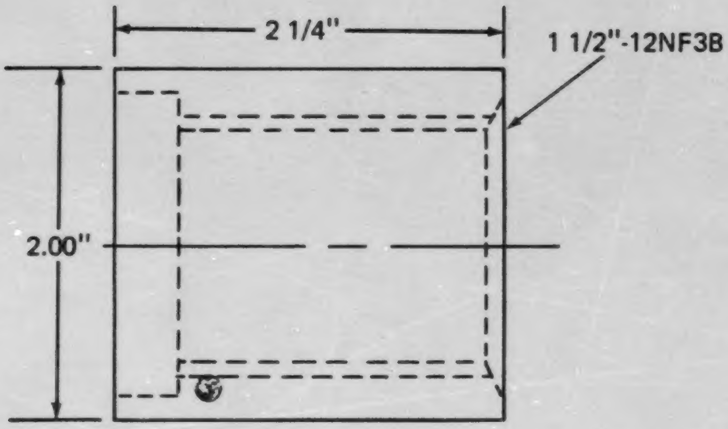
V. Turn off power, clean machine, and put away all tools

W. Complete evaluation sheet on following page

X. Turn in work and evaluation sheet to instructor

JOB SHEET #20--EVALUATION SHEET

NAME ______________________ SCORE ____________


2 1/4"
1 1/2"-12NF3B
2.00"

	YES	NO
Will part screw on test bolt?		
Is fit about a class three?		
Are threads smooth?		

Remarks ____

____

____

____

ENGINE LATHE OPERATIONS
UNIT III

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with engine lathe operations to their correct definitions. Write the correct numbers in the blanks. Continued on the next page.

_____ a. Two times single depth of thread; sum of depths of threads on each side of screw thread

_____ b. Ratio of the lengths of two sides of a triangle expressed as a decimal

_____ c. Distance from top (crest) of one thread to bottom (root) of thread perpendicular to axis of work

_____ d. Any angle used to define a dimension or give a location

_____ e. Angle of 90°

_____ f. Imaginary diameter equal to major diameter of threads minus single depth of thread

_____ g. Sum of two equal angles whose common side is center axis of work or part of a work

_____ h. Maximum and minimum dimensions allowed

_____ i. Distance from point on one thread to corresponding point on next thread; measured parallel to axis of work

_____ j. Uniform change in diameter of work along its axis

_____ k. Triangle with two sides at 90° to each other

_____ l. Side of a right triangle opposite the right angle

_____ m. Side of right triangle that forms one side of reference angle and one of the sides of right angle

_____ n. Ratio of length of side opposite to the hypotenuse

_____ o. Ratio of length of side opposite to length of side adjacent

_____ p. Side of a right triangle opposite a designated reference angle; forms one side of right angle

1. Taper
2. Single depth of thread
3. Included angle
4. Tolerance
5. Pitch
6. Reference angle
7. Limits
8. Double depth of thread
9. Right angle
10. Pitch diameter
11. Right triangle
12. Trigonometric function
13. Interior angle
14. Side adjacent
15. Side opposite
16. Hypotenuse
17. Sine
18. Cosine
19. Tangent

TEST

_____q. Ratio of length of side adjacent to the hypotenuse

_____r. Angle that lies inside and between two adjacent lines

_____s. Permissible deviation from a design dimension

2. Match taper formulas to their correct applications. Write the correct numbers in the blanks.

_____a. Used to determine taper per foot of a part

_____b. Used to determine total taper of a part

_____c. Used to determine tailstock offset

_____d. Used to determine small diameter of a part if taper per inch and large diameter are known

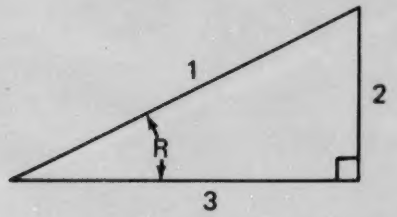
_____e. Used to determine taper per inch of a part

_____f. Used to determine large diameter of a part if taper per inch and small diameter are known

1. $D - d$
2. $\frac{D - d}{L}$
3. $\frac{D - d}{L} \times 12$ or tpi × 12
4. $(tpi \times L) + d$
5. $D - (tpi \times L)$
6. $\frac{tpi \times \text{Overall Length}}{2}$

3. Label sides of the following right triangles. Write the correct names in the blanks.

a.



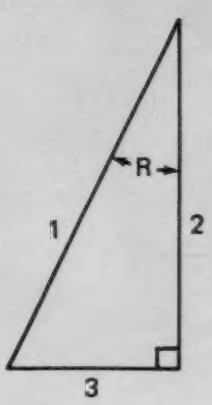
1) ________________________________

2) ________________________________

3) ________________________________

TEST

b.

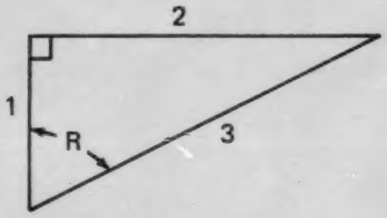


1) ____________________

2) ____________________

3) ____________________

c.

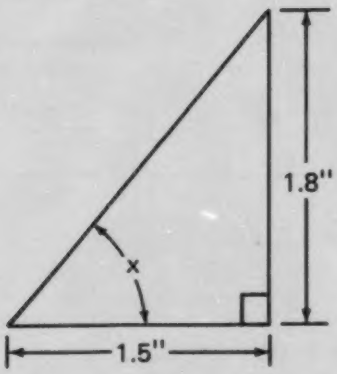


1) ____________________

2) ____________________

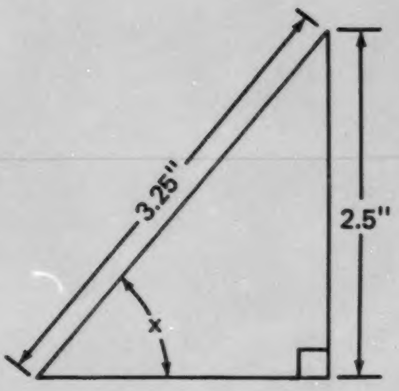
3) ____________________

4. Calculate trigonometric functions of angles. Write the correct answers in the blanks. (Show all work.)

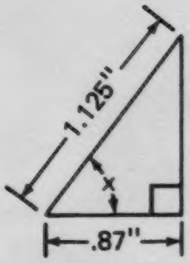


a. ____________________ X = ____________________

TEST



b. ______________________ X = ______________________



c. ______________________ X = ______________________

5. Determine angles, using trigonometric function tables. Refer to tables in *Handy Multipliers and Trigonometry Tables for Engineers.* Write the correct answers in the blanks.

a. Sine ______________________ = 0.18567

b. Tangent ______________________ = 0.51577

c. Cosine ______________________ = 0.23910

d. Tangent ______________________ = 1.2095

e. Sine ______________________ = 0.99511

f. Cosine ______________________ = 0.88674

TEST

6. Determine trigonometric functions of angles. Refer to tables in *Handy Multipliers and Trigonometry Tables for Engineers.* Write the correct answers in the blanks.

   a. Sine 15° 12' = ____________________

   b. Tangent 34° 27' = ____________________

   c. Cosine 49° 50' = ____________________

   d. Sine 60° 44' = ____________________

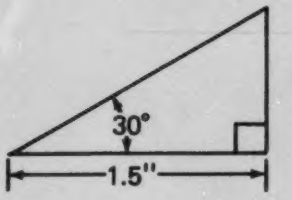
   e. Cosine 25° 15' = ____________________

   f. Tangent 73° 0' = ____________________

7. Calculate sides of right triangles . Refer to chart that follows and to the *Handy Multipliers and Trigonometry Tables for Engineers.* Write the correct answers in the blanks and show all work.

   (NOTE: Express decimals in ten-thousandths of an inch.)

UNKNOWN	KNOWN
Length of Hypotenuse	= Length of Side Opposite ÷ sine ∠ or = Length of Side Adjacent ÷ Cosine ∠
Length of Side Opposite	= Length of Hypotenuse x Sine or = Length of Side Adjacent x Tangent ∠
Length of Side Adjacent	= Length of Hypotenuse x Cosine ∠ or = Length of Side Opposite ÷ Tangent ∠

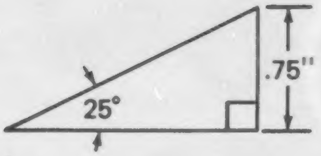


a.

1) Length of hypotenuse = ____________________

2) Length of side opposite = ____________________

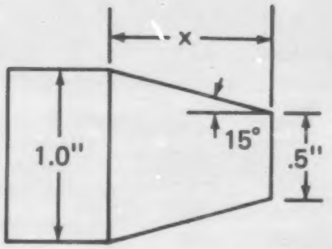
TEST



1) Length of side adjacent = ______________________

b.

2) Length of hypotenuse = ______________________



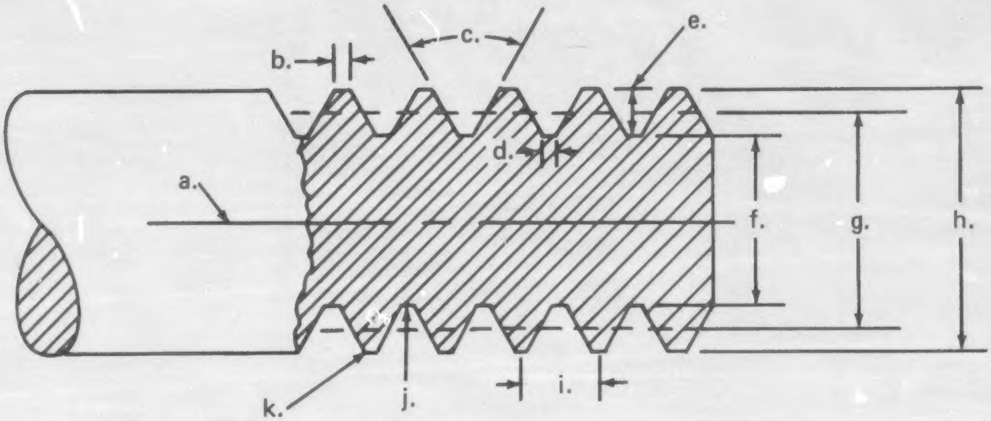
What is the missing length?

c.

X = ______________________________________

TEST

8. Name the parts of an American National thread form.


a.
b.
c.
d.
e.
f.
g.
h.
i.
j.
k.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

i. ____________________

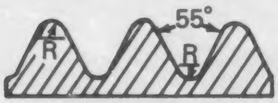
j. ____________________

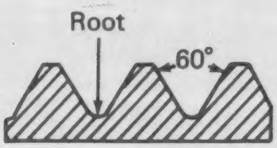
k. ____________________

TEST

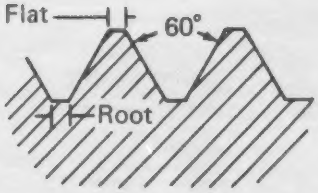
9. Identify thread forms. Write the correct names in the blanks.

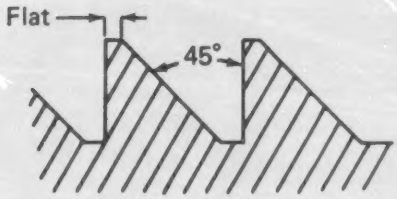
Sharp "V"
American National
Unified
Brown and Sharpe worm
Square
Buttress
Whitworth
Acme



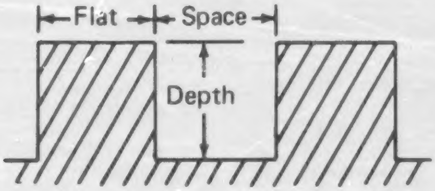


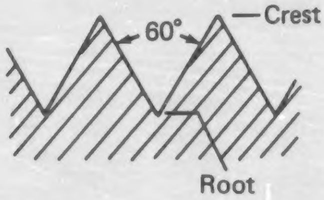
a. ______________________________ b. ______________________________


Flat
60°
Root

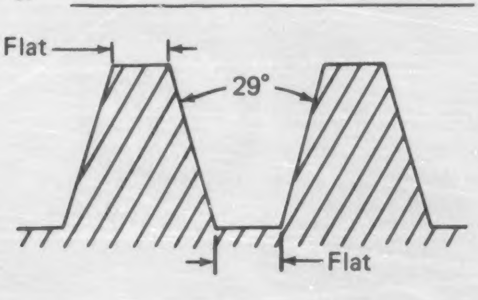


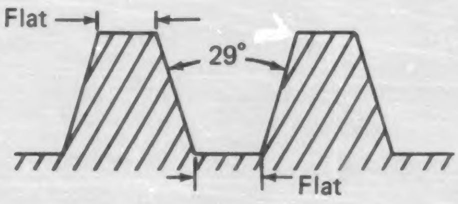
c. ______________________________ d. ______________________________


Flat
Space
Depth


60°
Crest
Root

e. ______________________________ f. ______________________________


Flat
29°
Flat


Flat
29°
Flat

g. ______________________________ h. ______________________________

TEST

10. Write the formulas used to calculate dimensions for an American National thread form.

    a. Pitch (P)--

    b. Single depth of thread (D)--

    c. Width of flat (F)--

    d. Compound feed depth (C)--

11. List methods of measuring thread pitch diameter.

    a. ____________________

    b. ____________________

    c. ____________________

    d. ____________________

    e. ____________________

(NOTE: Test questions 12-14 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

12. Use shop formulas to calculate taper dimensions.

13. Plan production operations.

14. Demonstrate the ability to

    a. Remove and install a lathe chuck.

    b. Perform a facing operation.

    c. Face a part to length.

    d. Perform a straight turning operation.

    e. Turn a part with square shoulder to length.

    f. Use dial indicator to align work in four-jaw chuck.

    g. Perform chamfer operations.

    h. Perform recessing operations.

TEST

i. Perform a center-drilling operation.

j. Perform a knurling operation.

k. Drill and ream a hole.

l. Use lathe center to align and start a tap.

m. Perform cutoff operation.

n. Turn between centers.

o. Turn a taper with taper attachment.

p. Turn a taper with compound.

q. Perform boring operations.

r. Cut external threads to a relief.

s. Pick up threads.

t. Cut internal threads.

ENGINE LATHE OPERATIONS
UNIT III

ANSWERS TO TEST

1. a. 8
   - b. 12
   - c. 2
   - d. 6
   - e. 9
   - f. 10
   - g. 3
   - h. 7
   - i. 5
   - j. 1
   - k. 11
   - l. 16
   - m. 14
   - n. 17
   - o. 19
   - p. 15
   - q. 18
   - r. 13
   - s. 4

2. a. 3
   - b. 1
   - c. 6
   - d. 5
   - e. 2
   - f. 4

3. a.
   1) Hypotenuse
   2) Side opposite
   3) Side adjacent

   b.
   1) Hypotenuse
   2) Side adjacent
   3) Side opposite

   c.
   1) Side adjacent
   2) Side opposite
   3) Hypotenuse

4. a. Tangent = 1.2000
   - b. Sine = 0.76923
   - c. Cosine = 0.77333

5. a. 10° 42'
   - b. 27° 17'
   - c. 76° 10'
   - d. 50° 25'
   - e. 84° 20'
   - f. 27° 32'

ANSWERS TO TEST

6. a. 0.26219
   b. 0.68600
   c. 0.64501
   d. 0.87235
   e. 0.90445
   f. 3.2708

7. a. 1) 1.7320"
      2) 0.8660"
   b. 1) 1.6084"
      2) 1.7746"
   c. 0.9330"

8. a. Axis
   b. Flat
   c. Angle 60°
   d. Flat
   e. Single depth of thread
   f. Minor diameter
   g. Pitch diameter
   h. Major diameter
   i. Pitch
   j. Root
   k. Crest

9. a. Whitworth
   b. Unified
   c. American National
   d. Buttress
   e. Square
   f. Sharp "V"
   g. Brown and Sharpe worm
   h. Acme

10. a. $P = \frac{1}{N}$ (Number of threads per inch)
   b. $D = 0.6495 \times P$ or $D = \frac{0.6495}{N}$
   c. $F = 0.125 \times P$ or $F = \frac{0.125}{N}$
   d. $C = 0.75 \times P$ or $C = \frac{0.75}{N}$

11. a. Screw pitch micrometer
   b. Thread triangles with standard micrometer
   c. Three-wire with standard micrometer
   d. Thread snap gauges
   e. Plug on ring gauges

ANSWERS TO TEST

12. Evaluated to the satisfaction of the instructor

13. Evaluated to the satisfaction of the instructor

14. Performance skills evaluated to the satisfaction of the instructor

TURRET LATHE OPERATIONS
UNIT IV

UNIT OBJECTIVE

After completing this unit, the student should be able to identify parts of the turret lathe, set up for part, and set tools and stops to produce a part to specification from a blueprint. This knowledge will be shown by completing assignment sheets, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with turret lathe operations to their correct definitions.
2. Describe use of the turret lathe.
3. Match types of turret lathes to their correct descriptions.
4. Identify parts of the ram-type turret lathe.
5. Name basic operations performed on a turret lathe.
6. Name methods of holding work.
7. Match toolholders used in the hexagon turret to their correct descriptions/uses.
8. Arrange in order steps to consider when planning sequence of operations.
9. Identify turret lathe operations and sequencing.
10. Plan sequence of operations for turret lathe.
11. Demonstrate the ability to
    a. Use turret lathe controls to adjust stop rolls.
    b. Produce Part "A" on the turret lathe.
    c. Produce Part "B" on the turret lathe.

TURRET LATHE OPERATIONS
UNIT IV

SUGGESTED ACTIVITIES

I. Suggested activities

  A. Make transparencies.

  B. Provide students with objective sheet.

  C. Provide students with information, assignment, and job sheets.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

  H. Reteach and retest if necessary.

II. Instructional materials

  A. Objective sheet

  B. Suggested activities

  C. Information sheet

  D. Transparency masters

    1. TM #1--Ram-Type Turret Lathe

    2. TM #2--Saddle Turret Lathe

    3. TM #3--Vertical Turret Lathe

    4. TM #4--Ram-Type Turret Lathe (Basic Parts)

  E. Assignment Sheet

    1. Assignment Sheet #1--Identify Turret Lathe Operations and Sequencing

    2. Assignment Sheet #2--Plan Sequence of Operations for Turret Lathe

  F. Answers to assignment sheets

  G. Job Sheet

    1. Job Sheet #1--Use Turret Lathe Controls and Adjust Stop Rolls

    2. Job Sheet #2--Produce Part "A" on the Turret Lathe

    3. Job Sheet #3--Produce Part "B" on the Turret Lathe

SUGGESTED ACTIVITIES

H. Test

I. Answers to test

III. Unit references

A. Anderson, James, and Earl E. Tatro. *Shop Theory,* 5th ed. New York: McGraw-Hill, Inc., 1968.

B. Krar, S.F., and J.S. Oswald. *Turning Technology.* Albany, New York: Litton Educational Publishing, Inc./Division of Delmar Publishing Company, 1971.

C. *Machinery Repair 2 and 3.* Bureau of Naval Personnel, Navy Training Course, NAVPERS 10530-6, 1966.

D. *Service Manuals #3, #4, and #5,* "Universal Ram-Type Turret Lathe." Cleveland, Ohio: Warner and Swasey Co., 1941.

TURRET LATHE OPERATIONS
UNIT IV

INFORMATION SHEET

I. Terms and definitions

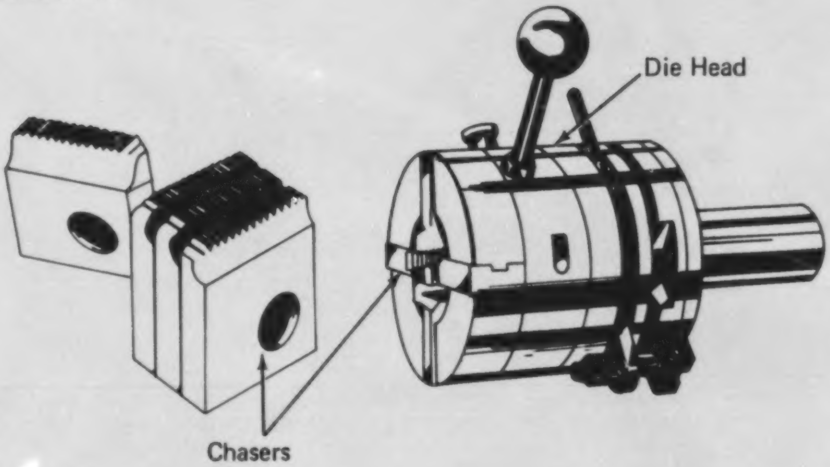
A. Bar feed--Mechanical feed that moves bar through spindle to a positive stop

B. Chasers--Thread-cutting portion of a die head; set of four numbered for size and number of threads per inch (Figure 1)

(NOTE: Chasers may be removed from die head and sharpened; consult machinery handbook or other charts for grinding instructions.)

EXAMPLE:

FIGURE 1



C. Chucking part--Work turned from individual piece of material while being held in chuck

D. Slug--Rough casting, forging, or length of precut bar stock

E. Soft jaws--Jaws made of a soft material cut or bored so diameter or radius of jaw is same as work; used to chuck finished work surfaces

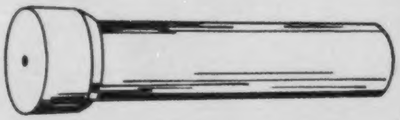
INFORMATION SHEET

F. Stock stop--Stop that has a flat end with bearings, allowing it to revolve with the work; mounted in a hexagon turret (Figure 2)

(NOTE: Hole in center allows for protrusion left from cutoff operation.)

EXAMPLE:

FIGURE 2



G. Turret--Indexing tool holder that holds more than one tool

II. Use of the turret lathe--Used to produce several identical parts by using several mounted in the hexagon turret, square turret, and backside tool post

III. Types of turret lathes (Transparencies #1-#3)

A. Ram-type--Easy-handling machine designed for bar stock work up to about three inches or chucking work up to about twenty inches in diameter; saddle remains fixed, and length of ram stroke varies with size of machine (four inches to thirteen inches)

B. Saddle-type--Designed for larger work; hexagon turret and saddle unit move along bed ways; length of cut is limited by length of machine bed

(NOTE: This type of lathe has a fixed-center hexagon turret or a cross-sliding hexagon turret that moves along the bed.)

C. Vertical-type--Designed so that chuck is horizonal, with a vertical slide and a hexagon turret mounted to a slide; chuck or work-holding device ranges in diameter from twenty-eight inches to ten feet; used primarily for large, heavy work

IV. Parts of the ram-type turret lathe (Transparency #4)

A. Longitudinal stop rod

B. Collet chuck

C. Longitudinal-feed stop roll

INFORMATION SHEET

D. Spindle control lever
E. Bar-feed head
F. Start/stop switch
G. Collet chuck and bar-feed lever
H. Preselector drum housing
I. Square turret
J. Chip pan
K. Hydraulic pump and motor drive
L. Longitudinal-feed engagement lever
M. Feed reverse lever
N. Feed selector levers
O. Master stop screw
P. Cross slide
Q. Carriage
R. Feed shaft
S. Turret slide
T. Turret-feed engagement lever
U. Turnstile
V. Stop rolls
W. Cross-feed engagement lever
X. Hexagon turret
Y. Bed ways
Z. Preselector handwheel
AA. Apron
BB. Longitudinal-feed handwheel
CC. Saddle
DD. Backside tool post
EE. Feed shift levers

INFORMATION SHEET

V. Basic operations performed on a turret lathe (Assignment Sheet #1)

A. Hexagon turret

1. Turning
2. Facing
3. Stock positioning
4. Center drilling
5. Drilling
6. Reaming
7. Threading with tap and die
8. Threading with thread-cutting attachment
9. Boring
10. Taper cutting inside and outside
11. Recessing
12. Chamfering
13. Knurling
14. Forming

B. Square turret

1. Turning
2. Facing
3. Knurling
4. Forming
5. Boring
6. Recessing
7. Chamfering
8. Cutting off
9. Tapering

INFORMATION SHEET

C. Backside tool post

(NOTE: Although the backside tool post can be set up to perform a number of operations, it is used primarily for cutoff operations or for an additional station when the turret positions are filled.)

1. Turning
2. Facing
3. Knurling
4. Forming
5. Recessing
6. Chamfering
7. Cutting off
8. Tapering

VI. Methods of holding work

A. Collet

B. Three-jaw universal chuck

C. Air or hydraulic-operated chuck

D. Soft jaws on chuck

E. Fixture

F. Face plate

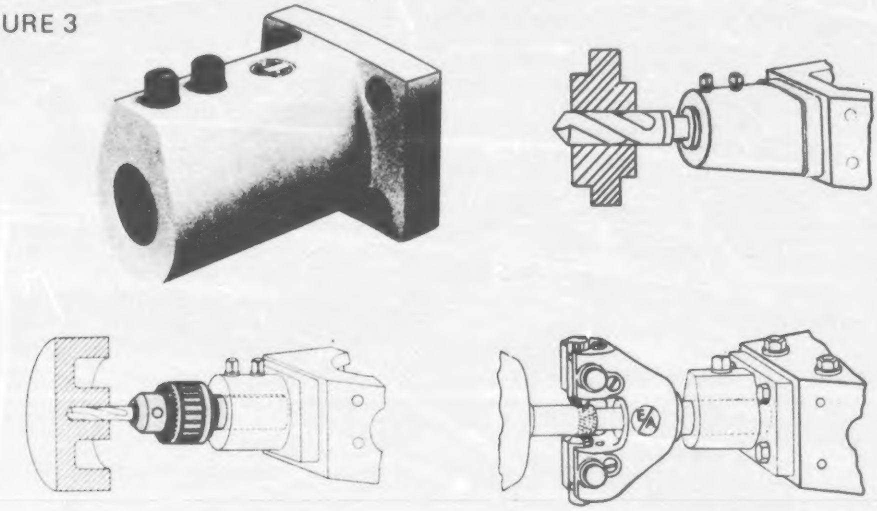
INFORMATION SHEET

VII. Descriptions and uses of toolholders used in the hexagon turret (Figures 3-18)

A. Flanged toolholder--Used to hold drills, drill chucks, and other tools; sometimes referred to as *bar-type holder*; has straight bore with clamping screws that hold tool or bushing adapters with straight or tapered bores

EXAMPLE:

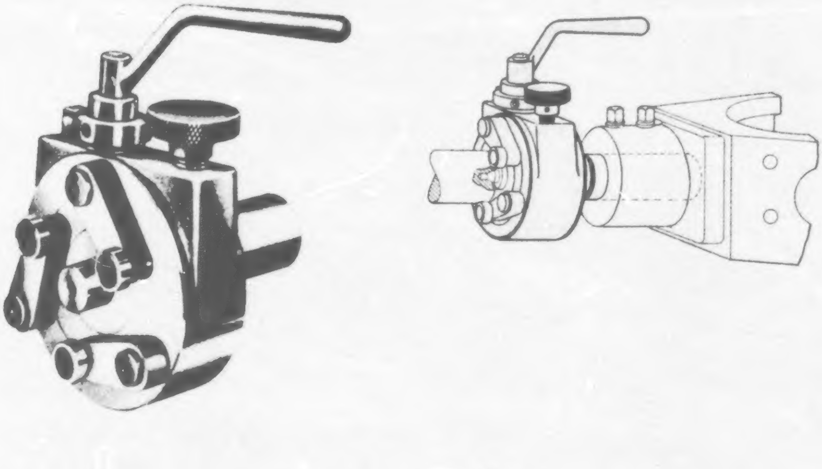
FIGURE 3



B. Center-drilling attachment--Used to center drill work that requires accuracy in location of center-drilled hole; support rollers help keep part concentric

EXAMPLE:

FIGURE 4

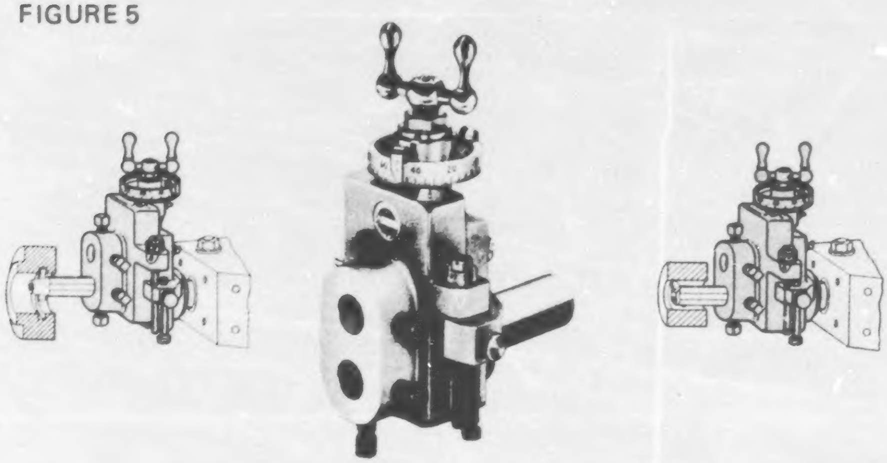


INFORMATION SHEET

C. Slide toolholder--Allows tool to be adjusted off center for operations such as boring

EXAMPLE:

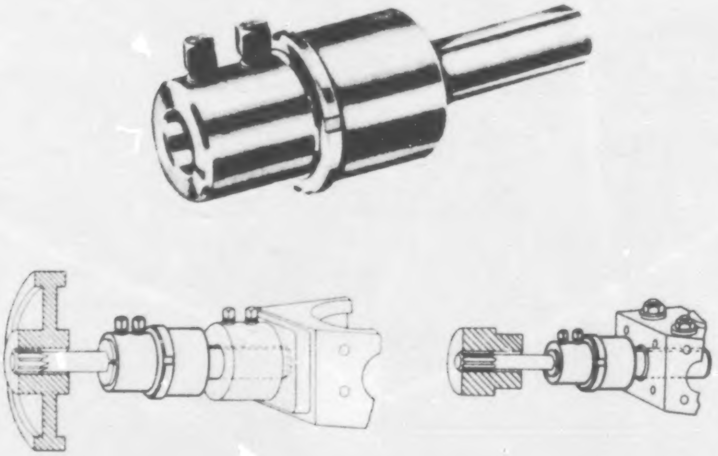
FIGURE 5



D. Floating reamer-holder--Allows reamer to seek its center

EXAMPLE:

FIGURE 6

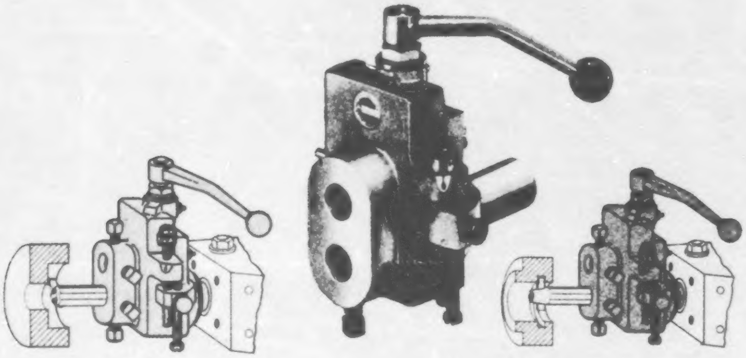


INFORMATION SHEET

E. Quick-acting slide tool--Used for internal and external recessing and back facing, and for internal facing

EXAMPLE:

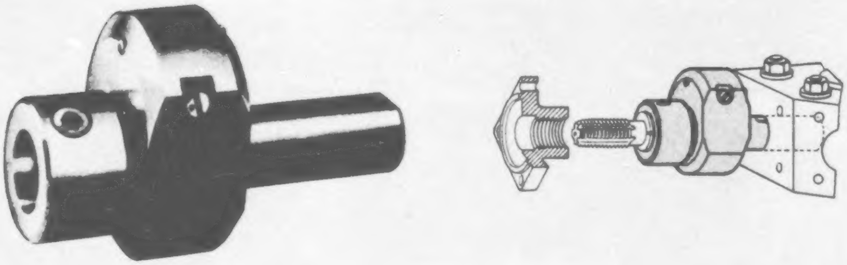
FIGURE 7



F. Releasing tap-holder--Automatically releases, allowing tap to revolve with work when tap has reached preset depth

EXAMPLE:

FIGURE 8

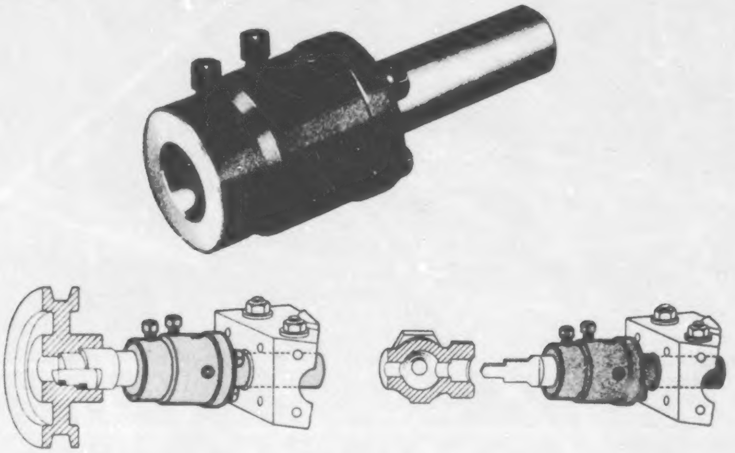


INFORMATION SHEET

G. Adjustable cutter-holder--Used in flanged toolholders; can be adjusted

EXAMPLE:

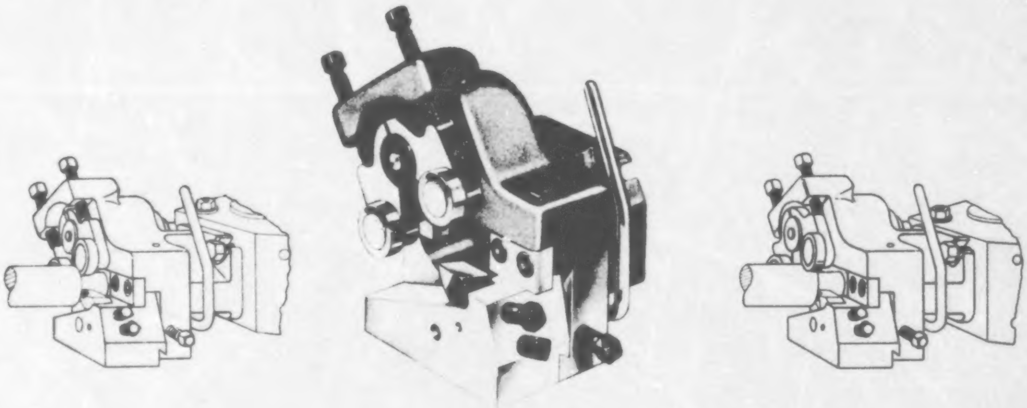
FIGURE 9



H. Bar-turner toolholder--Used to work on long bars; has rollers to support the work

EXAMPLE:

FIGURE 10

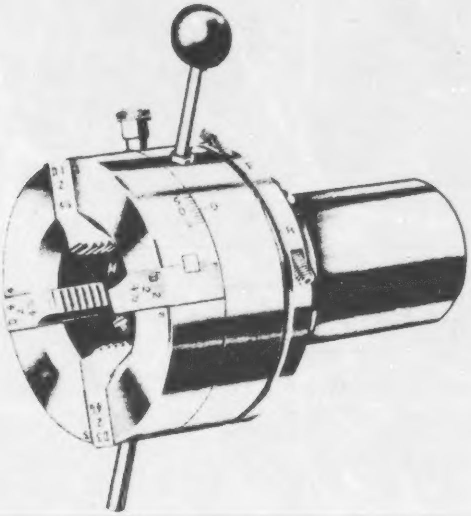


INFORMATION SHEET

I. Self-releasing die head--Used for cutting external threads; spring-loaded; pops open when preselected length is reached

EXAMPLE:

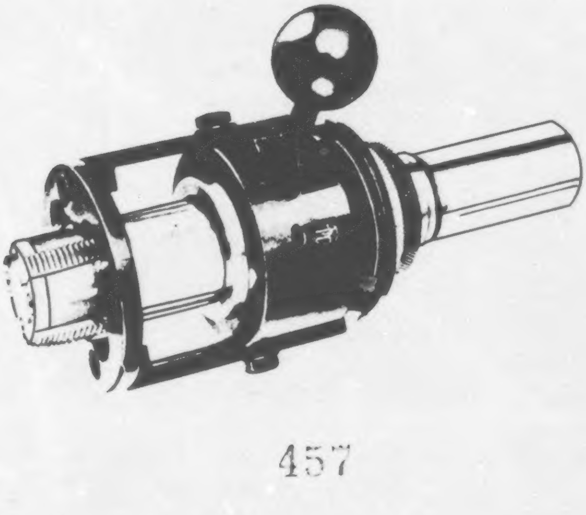
FIGURE 11



J. Collapsible tap--Used for tapping holes; thread chasers retract for removal

EXAMPLE:

FIGURE 12

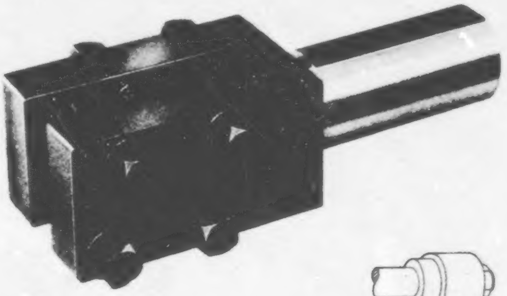


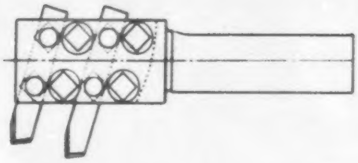
INFORMATION SHEET

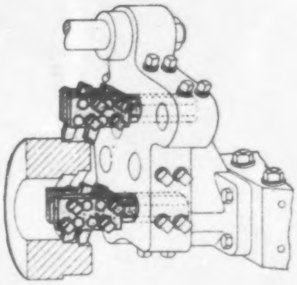
K. Multiple cutter-holder--Used to hold one or more tools to stagger cut, shape, form, or perform more than one operation at a time

EXAMPLE:

FIGURE 13



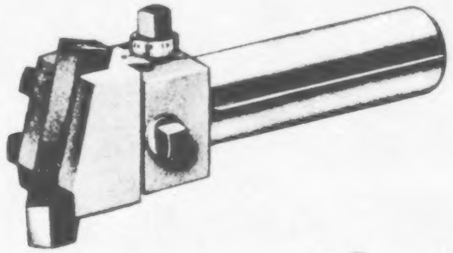


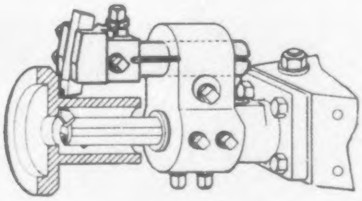


L. Adjustable cutter-holder (precision)--Used to turn work with single tool; can be adjusted

EXAMPLE:

FIGURE 14



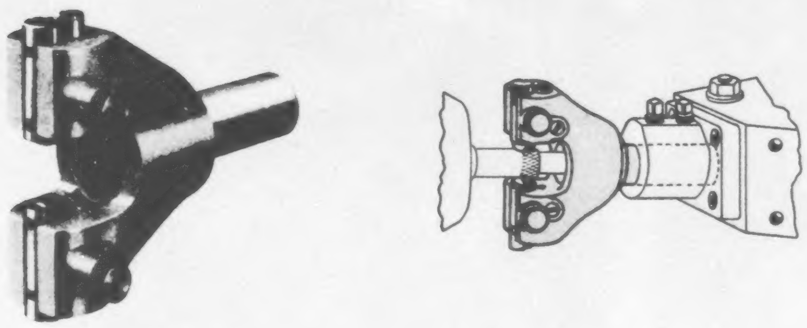


INFORMATION SHEET

M. Adjustable knurl-holder--Can be adjusted to form a straight or diamond knurl on work of different diameters

EXAMPLE:

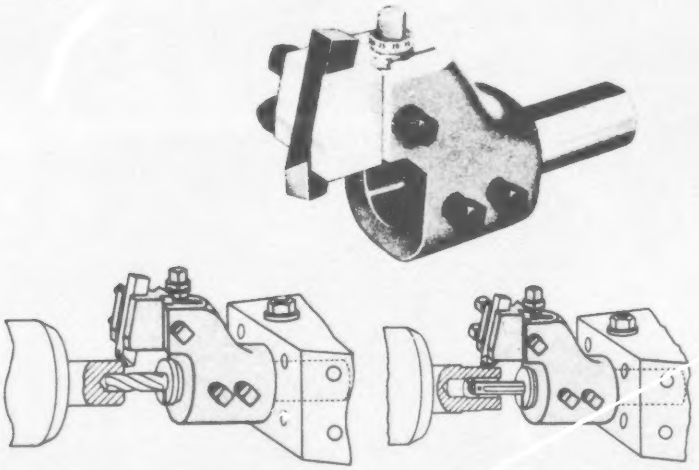
FIGURE 15



N. Adjustable knee-tool--Used primarily to turn; can also hold drills, reamers, or boring tools; can be adjusted

EXAMPLE:

FIGURE 16

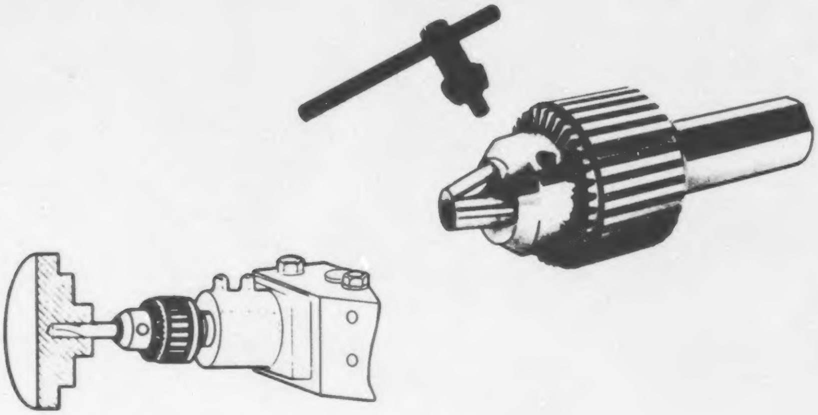


INFORMATION SHEET

O. Drill chuck--Used to hold drills, reamers, and center drills

EXAMPLE:

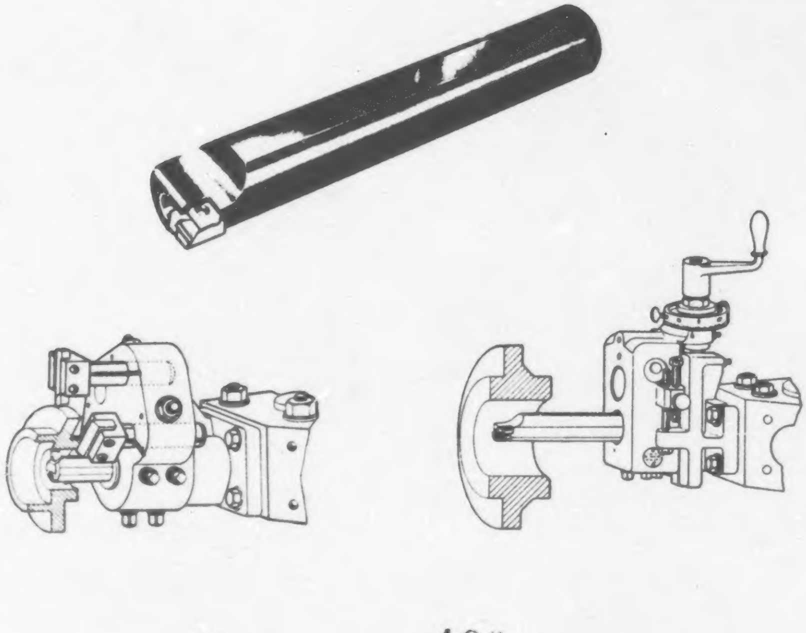
FIGURE 17



P. Boring bar--Enlarges an existing hole

EXAMPLE:

FIGURE 18



INFORMATION SHEET

VIII. Sequence of operations (Assignment Sheet #2)

(NOTE: The planning of the sequence of operations is much the same as for that of an engine lathe; however, several tools may be mounted and indexed into position when required. Occasionally more than one tool is in operation at the same time. See Figure 19.)

A. Examine blueprint for operations

B. List operations and arrange in order to be performed

C. List where operations will be made (square turret, hexagon turret, backside tool post)

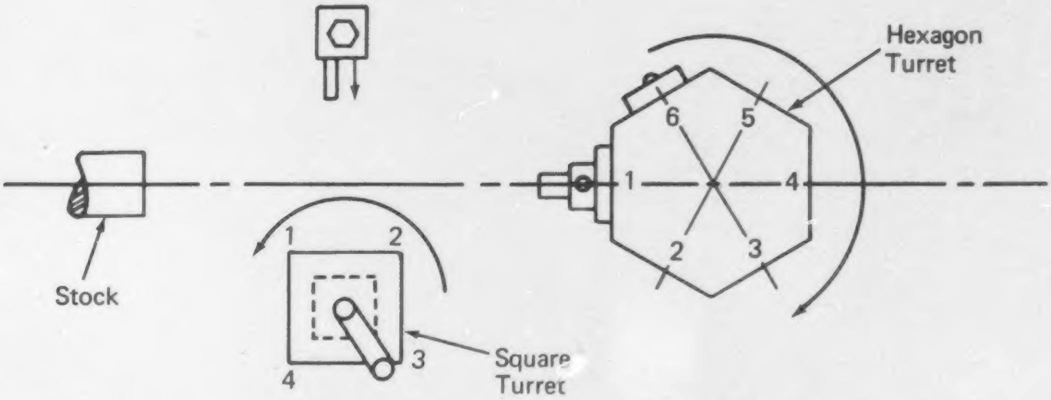
EXAMPLE: Cut V-groove (square turret)

D. Correlate sequence of operations and tool locations

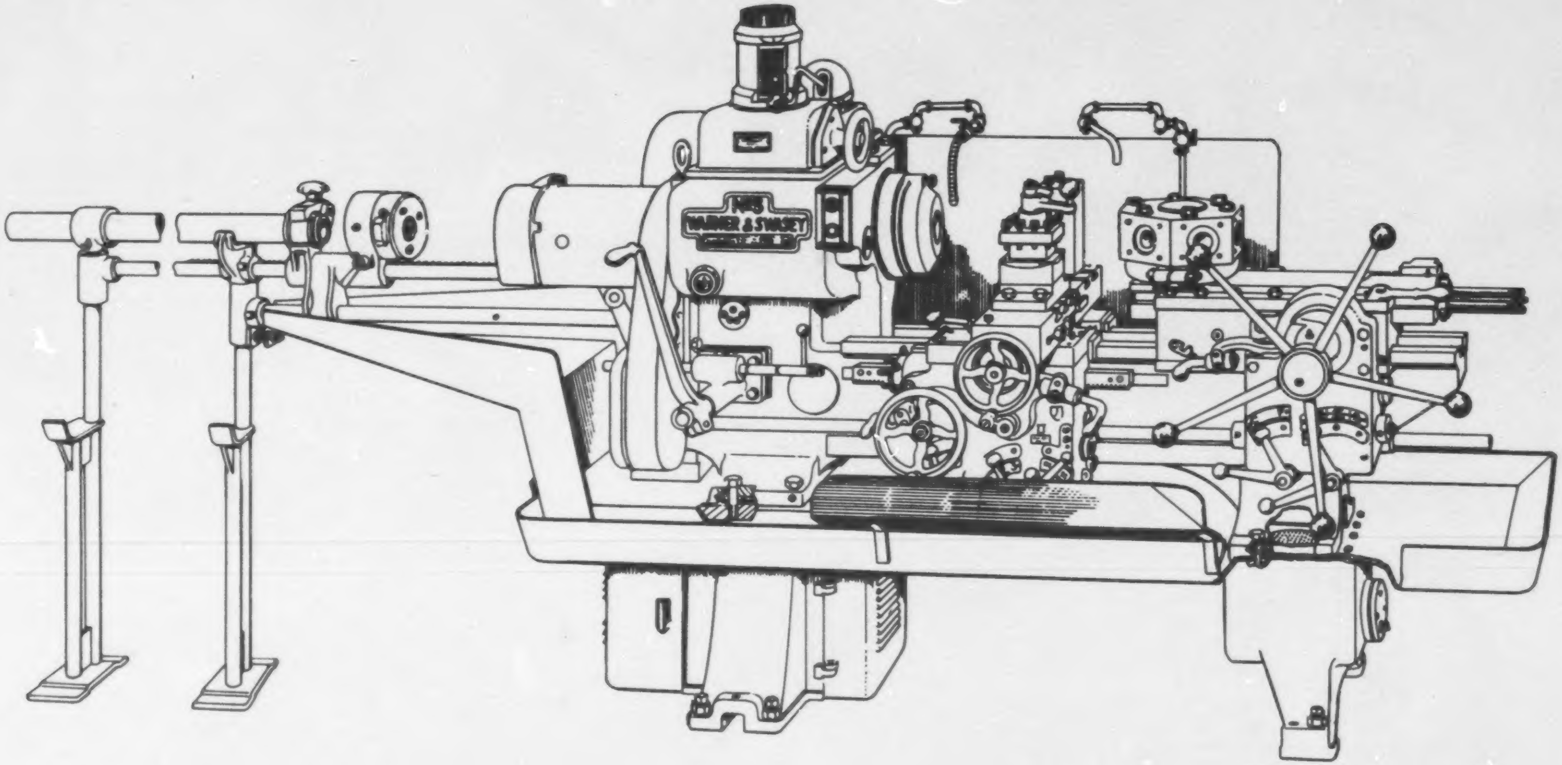
EXAMPLE:

1.	Feed stock to stock stop	Hex 1
2.	Center drill work	Hex 2
3.	Cut recess	Sq 1

FIGURE 19



Ram-Type Turret Lathe


W&S
WARNER & SWASEY

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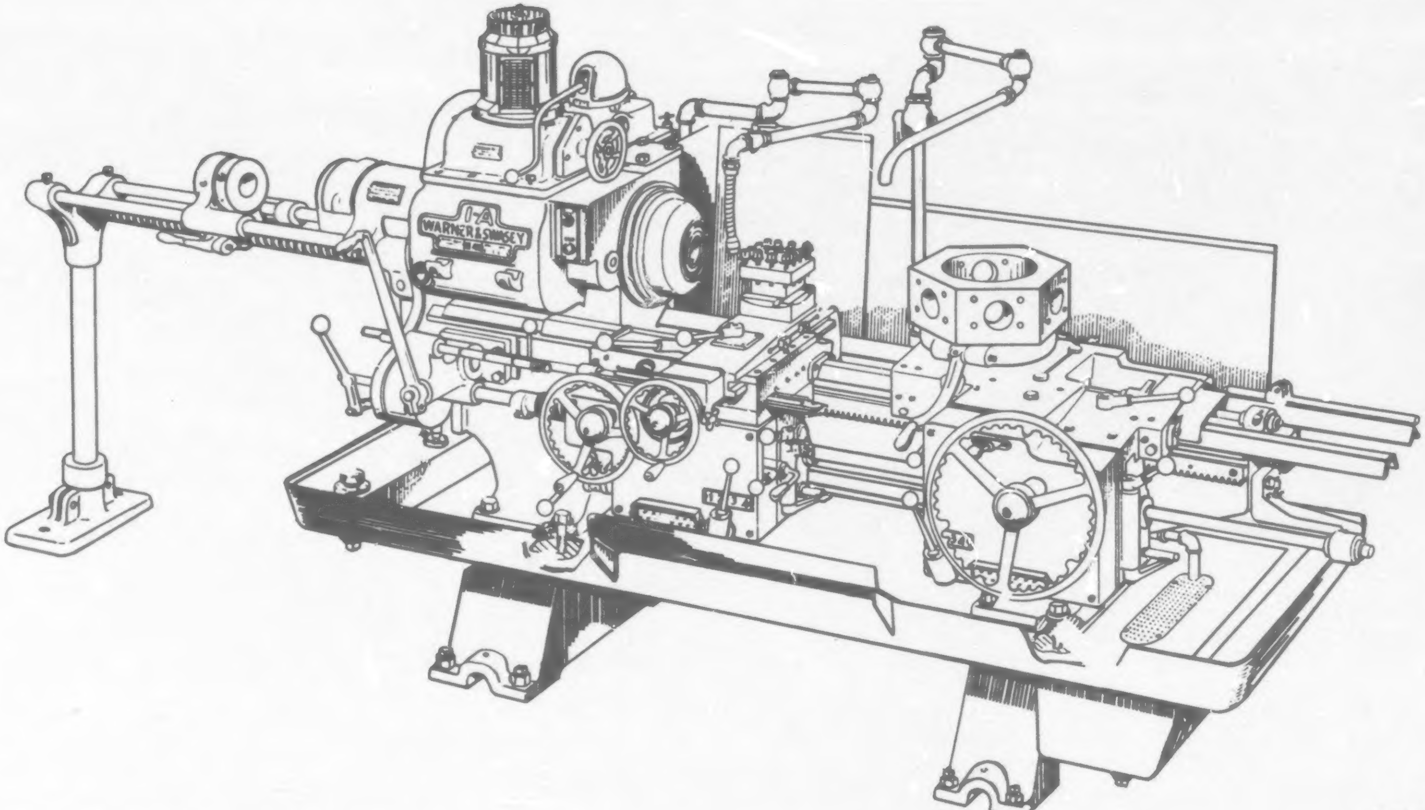
Saddle Turret Lathe


I-A
WARNER & SWASEY

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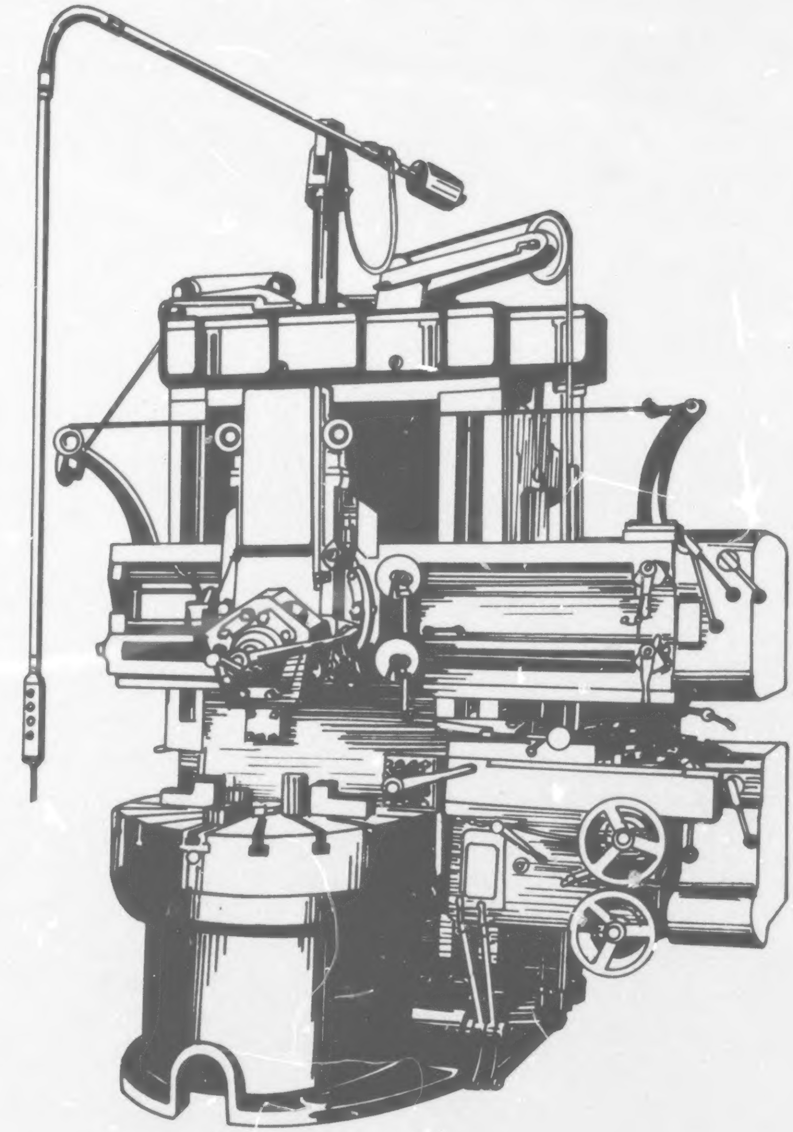
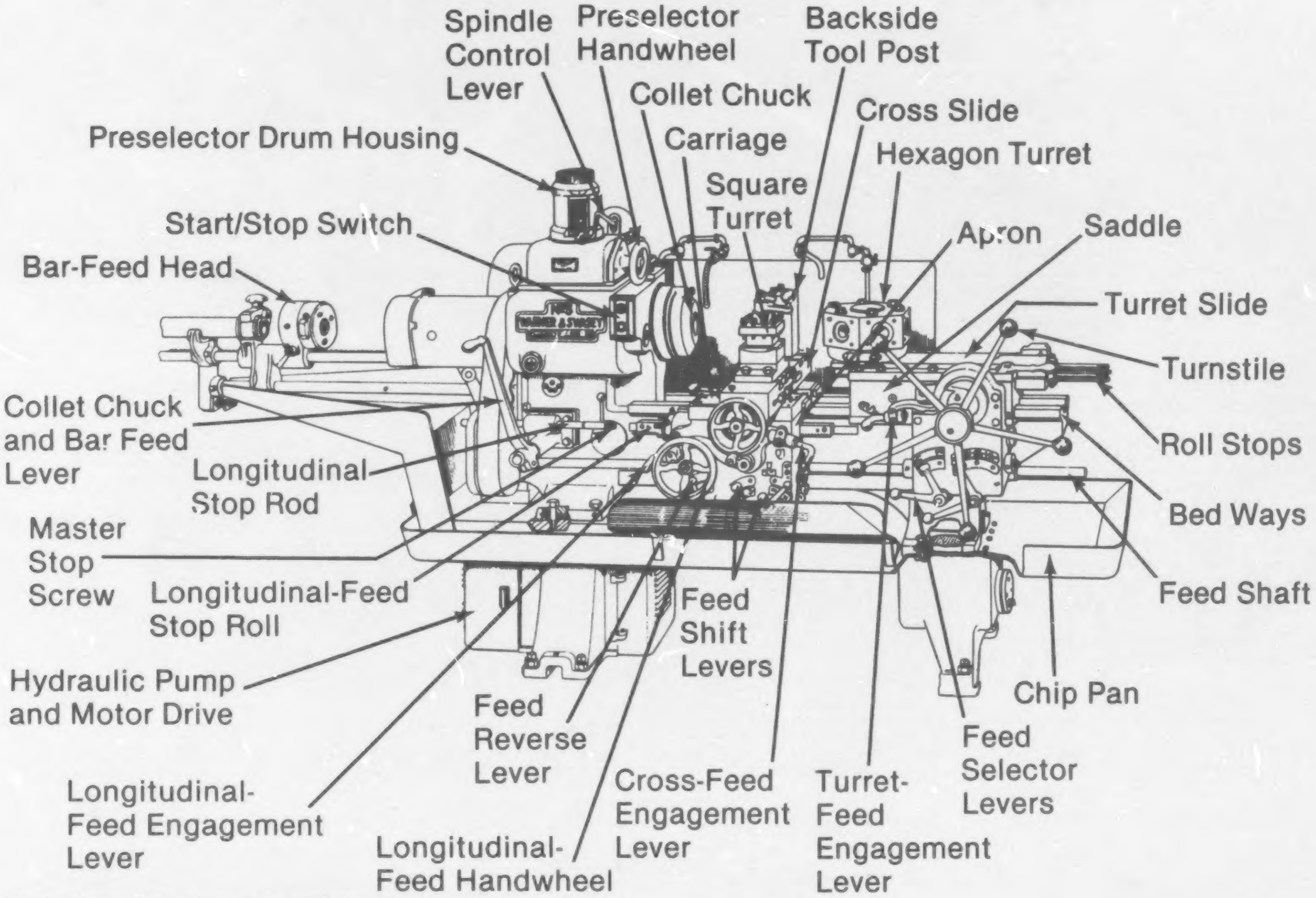
Vertical Turret Lathe



Used with permission of American Steel Foundation, Chicago, Illinois.

Parts of the Ram-Type Turret Lathe



Spindle Control Lever
Preselector Handwheel
Backside Tool Post
Collet Chuck
Cross Slide
Preselector Drum Housing
Carriage
Hexagon Turret
Square Turret
Start/Stop Switch
Apron
Saddle
Bar-Feed Head
Turret Slide
Turnstile
Collet Chuck and Bar Feed Lever
Roll Stops
Longitudinal Stop Rod
Bed Ways
Master Stop Screw
Longitudinal-Feed Stop Roll
Feed Shift Levers
Feed Shaft
Hydraulic Pump and Motor Drive
Chip Pan
Feed Reverse Lever
Feed Selector Levers
Longitudinal-Feed Engagement Lever
Cross-Feed Engagement Lever
Turret-Feed Engagement Lever
Longitudinal-Feed Handwheel

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TM #4

MS II - 487

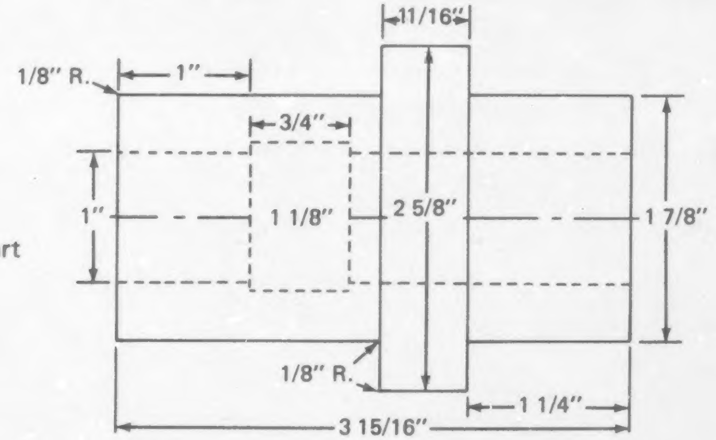
TURRET LATHE OPERATIONS
UNIT IV

ASSIGNMENT SHEET #1--IDENTIFY TURRET LATHE OPERATIONS AND SEQUENCING

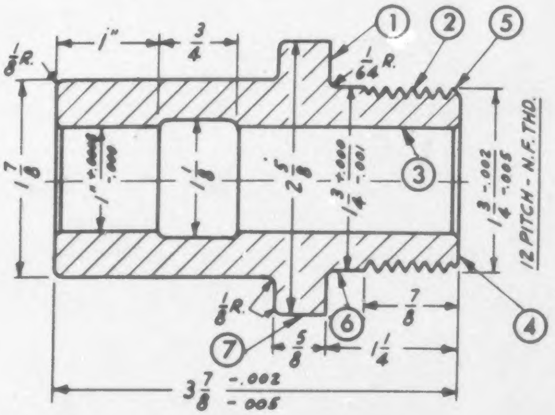
NAME ______________________________ SCORE ______________

The turret lathe is a production machine designed to perform several operations; therefore, the operator must consider not only machining requirements but also the capabilities of the machine.

A. Use the machine setup on the following page to identify the location of each operation shown in the part below. Write the correct letters in the blanks. Assume that the tools are in the most convenient order to perform the operations.


11/16"
1/8" R.
1"
3/4"
1"
1 1/8"
2 5/8"
1 7/8"
1/8" R.
1 1/4"
3 15/16"

Cast Part


1/8 R.
1"
3/4
①
②
⑤
1/64 R.
1 7/8
1" +.0005 / -.000
1 1/8
2 5/8
1 3/4 +.000 / -.001
③
1 3/4 -.002 / -.005
12 PITCH - N.F. THD.
1/8 R.
⑥
7/8
④
⑦
5/8
1 1/4
3 7/8 -.002 / -.005

Finished Part

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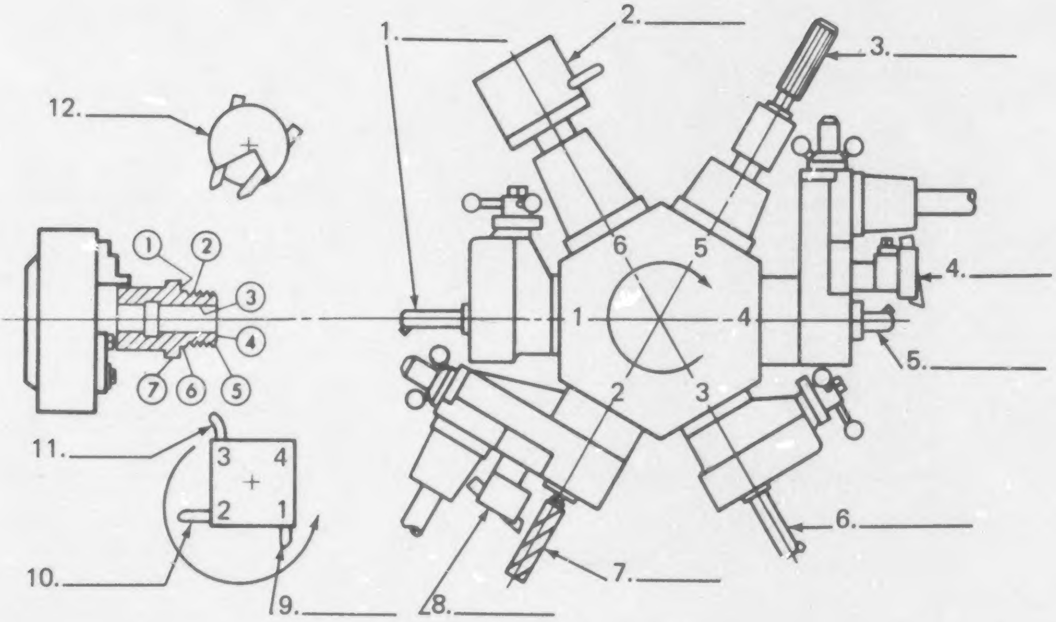
(NOTE: The end chucked has been premachined. The 1 7/8" diameter has been turned, and the end is faced with the 1/8" radius formed and the bore chamfered. The work has a 3/4" cast hole that must be finished; however, the 1 1/8" x 3/4" recess is cast to size.)

ASSIGNMENT SHEET #1

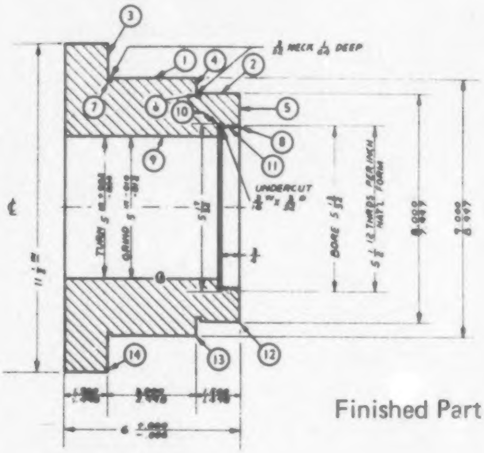

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
①
②
③
④
⑤
⑥
⑦
6
5
1
4
2
3
3
4
2
1

Used with permission of The Warner & Swasey Co.

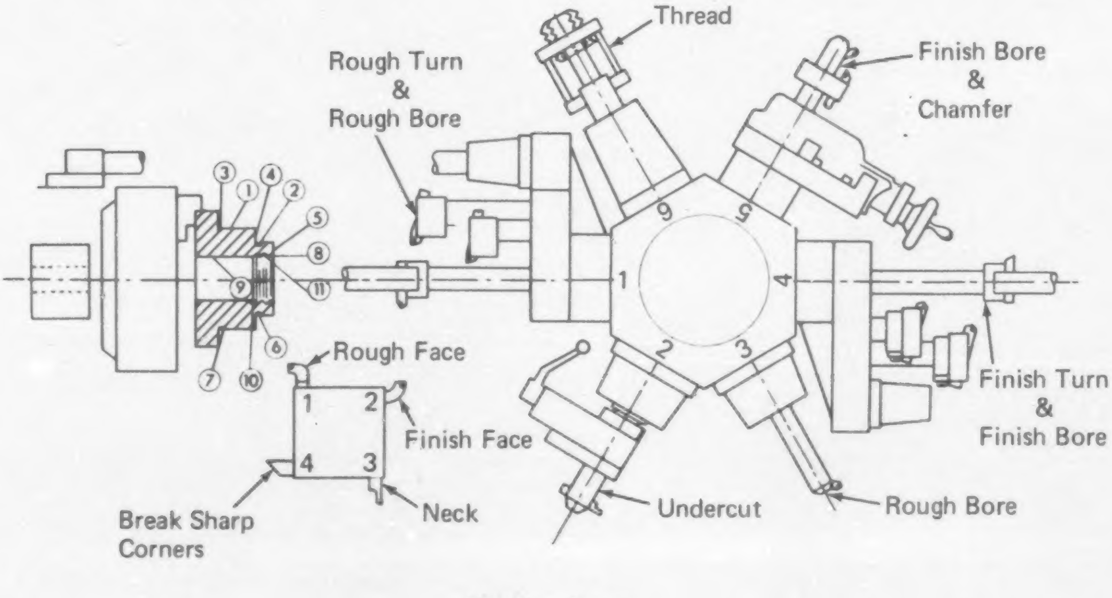
a. Chamfer bore (Surface 3)
b. Pilot bore (Surface 3)
c. Rough face (Surface 1 & 4)
d. Thread (Surface 2)
e. Ream (Surface 3)
f. Turn (Surface 7)
g. Rough turn (Surface 6)
h. Semi-finish bore (Surface 3)
i. Chamfer (Surface 5)
j. Finish face (Surface 1 & 4)
k. Finish turn (Surface 6)
l. Drill (Surface 3)

ASSIGNMENT SHEET #1

B. Use the illustrations of the finished part and machine setup below to complete the instructions that follow. Fill in the numbers of the correct surfaces and tool positions.


③
NECK DEEP
①
④
②
⑦
⑥
⑩
⑤
⑧
⑨
⑪
UNDERCUT
TURN
GRIND
BORE
12 THRDS PER INCH NAT'L FORM
⑭
⑬
⑫

Finished Part


Thread
Finish Bore
&
Chamfer
Rough Turn
&
Rough Bore
③
①
④
②
⑤
⑧
⑨
⑪
⑥
⑦
⑩
6
5
1
4
2
3
Rough Face
1
2
Finish Face
4
3
Break Sharp Corners
Neck
Undercut
Rough Bore
Finish Turn
&
Finish Bore

Machine Setup

Used with permission of the Warner & Swasey Co.

ASSIGNMENT SHEET #1

1. Rough turn surfaces ________ and _______, and rough bore ________ from hexagon turret Position _______.
2. Rough face surfaces _______ and _______ from square turret Position _______.
3. Rough face surface _______ from square turret Position _______, and rough bore surface _______ from hexagon turret Position _______.
4. Finish turn surfaces _______ and _______, and finish bore surface _______ from hexagon turret Position ________.
5. Finish face surfaces _______ and _______ from Position _______ of square turret.
6. Finish face surface _______ from square turret Position _______. Finish bore surface _______ and chamfer surface _______ from Position _______ of hexagon turret.
7. Neck surfaces _______ and _______ from Position _______ of square turret.
8. Break sharp edges on surfaces _______, _______, and _______ from square turret Position _______.
9. Recess or undercut surface _______ from Position _______ of hexagon turret.
10. Thread surface _______ from hexagon turret Position _______.

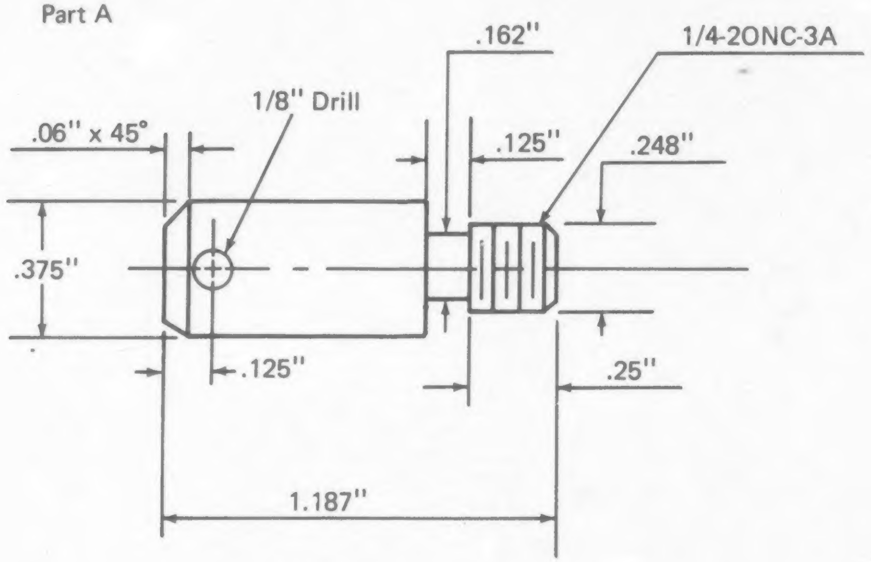
TURRET LATHE OPERATIONS
UNIT IV

ASSIGNMENT SHEET #2--PLAN SEQUENCE OF OPERATIONS FOR TURRET LATHE

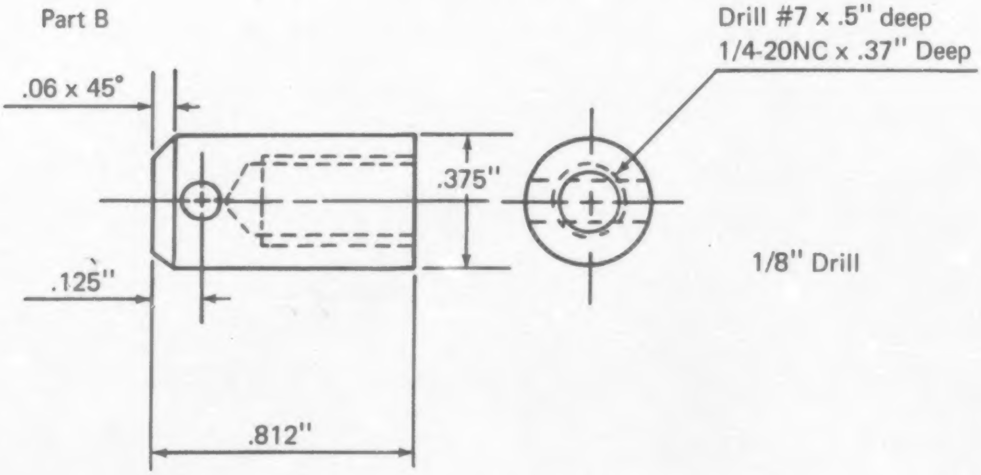
NAME________________________________ SCORE ____________

If a part is to be made correctly in the allotted production time, the arrangement of operations must be correct. Use the drawing below to answer the questions that follow.

Part A


.162"
1/4-20NC-3A
1/8" Drill
.06" x 45°
.125"
.248"
.375"
.125"
.25"
1.187"

Part B


Drill #7 x .5" deep
1/4-20NC x .37" Deep
.06 x 45°
.375"
.125"
1/8" Drill
.812"

ASSIGNMENT SHEET #2

A. List the tools required to make Parts A and B.

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________

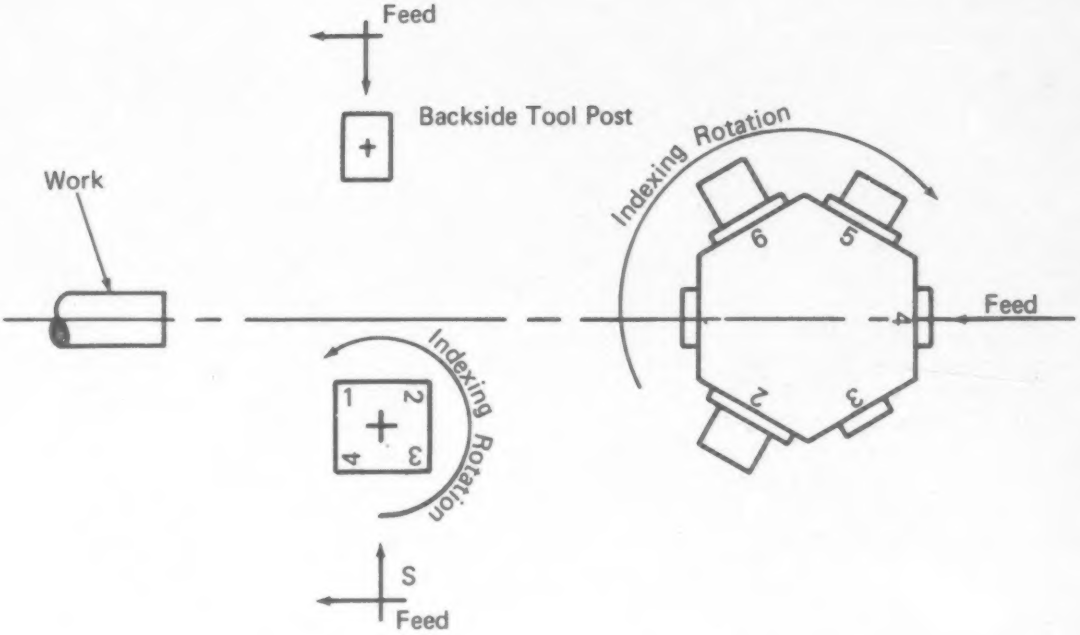
B. List in correct sequence the operations required to make Part A.

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________

C. List in correct sequence the operations required to make Part B.

1. ______________________
2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________

ASSIGNMENT SHEET #2

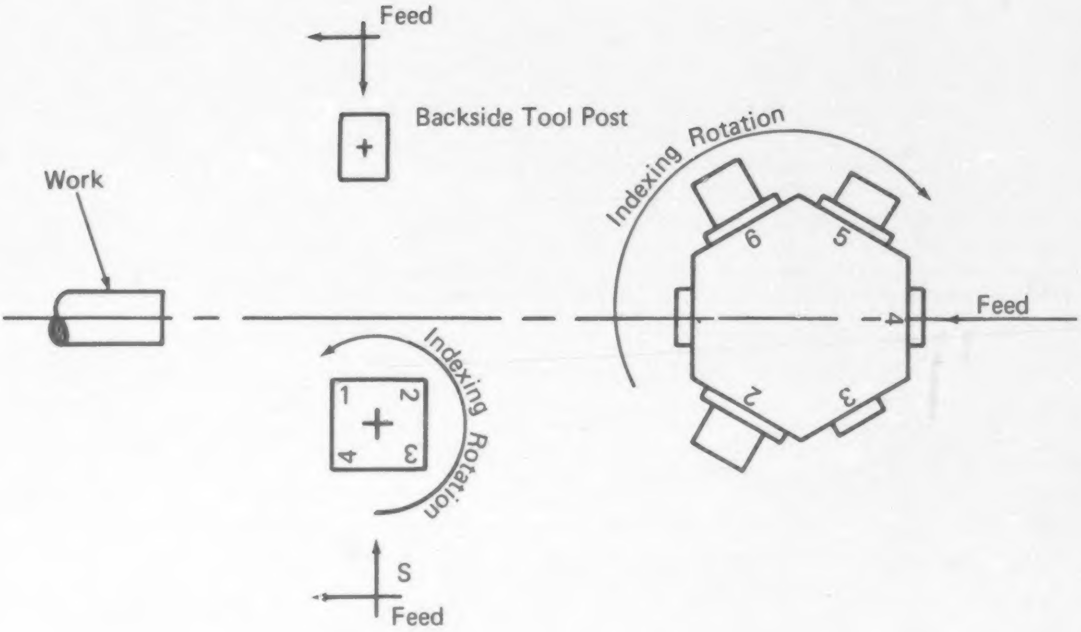

Feed
Backside Tool Post
Work
Indexing Rotation
6
5
4
3
2
Feed
Indexing Rotation
1
2
3
4
S
Feed

D. List the types of tool mounted in each position for the production of Part A.

(NOTE: Not all of the positions need to be used.)

1. Square turret
   a. Position 1 ____________________
   b. Position 2 ____________________
   c. Position 3 ____________________
   d. Position 4 ____________________
2. Backside tool post-- ____________________
3. Hexagon turret
   a. Position 1 ____________________
   b. Position 2 ____________________
   c. Position 3 ____________________
   d. Position 4 ____________________
   e. Position 5 ____________________
   f. Position 6 ____________________

ASSIGNMENT SHEET #2


Feed
Backside Tool Post
Work
Indexing Rotation
6
5
4
3
2
Feed
Indexing Rotation
1
2
3
4
S
Feed

E. List the types of tool mounted in each position for the production of Part B. (NOTE: Not all of the positions need to be used.)

1. Square turret
    a. Position 1 ____________________
    b. Position 2 ____________________
    c. Position 3 ____________________
    d. Position 4 ____________________
2. Backside tool post-- ____________________
3. Hexagon turret
    a. Position 1 ____________________
    b. Position 2 ____________________
    c. Position 3 ____________________
    d. Position 4 ____________________
    e. Position 5 ____________________
    f. Position 6 ____________________

TURRET LATHE OPERATIONS
UNIT IV

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

A.
1. b
2. d
3. e
4. k
5. a
6. h
7. l
8. g
9. i
10. f
11. c
12. j

B.
1. Rough turn surfaces 1 and 2, and rough bore surface 9 from hexagon turret Position 1.
2. Rough face surfaces 4 and 5 from square turret Position 1.
3. Rough face surface 3 from square turret Position 1, and rough bore surface 11 from hexagon turret Position 3.
4. Finish turn surfaces 1 and 2, and finish bore surface 9 from hexagon turret Position 4.
5. Finish face surfaces 4 and 5 from Position 2 of square turret.
6. Finish face surface 3 from square turret Position 2. Finish bore surface 11 and chamfer surface 8 from Position 5 of hexagon turret.
7. Neck surfaces 6 and 7 from Position 3 of square turret.
8. Break sharp edges on surfaces 12, 13, and 14 from square turret Position 4.
9. Recess or undercut surface 10 from Position 2 of hexagon turret.
10. Thread surface 11 from hexagon turret Position 6.

Assignment Sheet #2

(NOTE: Answers may vary, depending on equipment used and instructor's preference.)

A.
1. Turning tool
2. Facing tool
3. Recessing tool
4. Chamfering tool
5. Cutoff tool

ANSWERS TO ASSIGNMENT SHEETS

6. Self-releasing die head and 1/4-20NC die
7. Center drill, #3, in drill chuck
8. Drill, #7, in drill chuck
9. Tap, 1/4-20NC, in releasing tap holder

B. 1. Face
2. Turn
3. Recess
4. Thread
5. Chamfer
6. Cut off

C. 1. Face
2. Center drill
3. Drill
4. Tap
5. Chamfer
6. Cut off

D. 1. a. Facing tool
    b. Turning tool
    c. Recessing tool
    d. Chamfering tool
2. Cutoff tool
3. a. Stock stop
    b. Thread cutting tool
    c. --
    d. --
    e. --
    f. --

ANSWERS TO ASSIGNMENT SHEETS

E. 1. a. Facing tool

b. Chamfering tool

c. --

d. --

2. Cutoff tool

3. a. Stock stop

b. Center drill

c. Drill

d. Tap

e. --

f. --

TURRET LATHE OPERATIONS
UNIT IV

JOB SHEET #1--USE TURRET LATHE CONTROLS AND ADJUST STOP ROLLS

I. Equipment and materials

- A. Turret lathe with collet and bar feed
- B. Collet for 3/8" or 1/2" bar
- C. Steel bar, 1/2" or 3/8" diameter, 8' to 12' length

  (NOTE: Steel bar should have two lines around its circumference, one 1 inch from end, the other 3 inches from end.)

- D. Stock stop
- E. Adjustable boring-bar holder for hexagon turret and boring bar with cutting tool
- F. Steel rule, 6"
- G. Operator's manual for turret lathe
- H. Straight-blade screwdriver, 8"
- I. Turning tool

II. Procedure

- A. Mount material in bar feed
  1. Insert material in bar-feed tube, and slide it through bar-feed head

     (NOTE: There are several types of fingers or chucks that pull the stock and must be changed so that the bar feed device will grip the size of material you are using. Check with your instructor or consult operator's manual.)

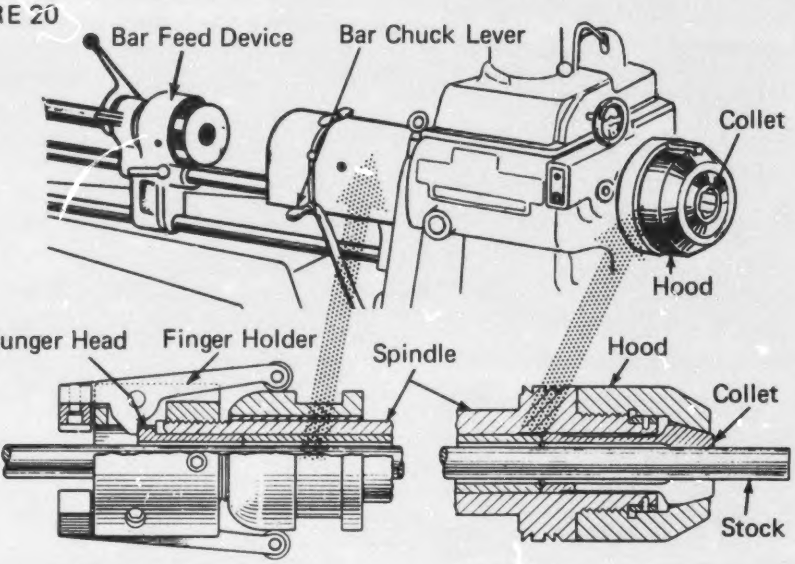
  2. Mount collet for size of material in spindle

JOB SHEET #1

3. Pull collet chuck and bar-feed lever to right, and slide stock through spindle (Figure 20)

   (NOTE: When collet chuck and bar-feed lever are pulled right, the collet is pulled back from the taper in the hood allowing stock to feed through the collet; when lever is pushed left, the collet is forced into the head, thus clamping the stock in place.)

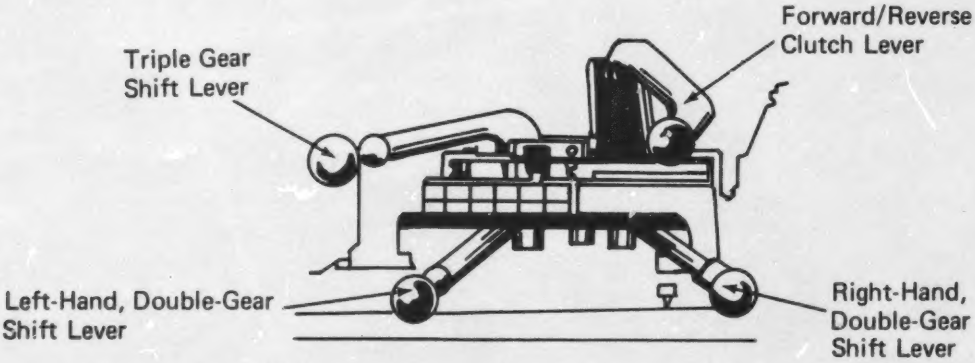
FIGURE 20


Bar Feed Device
Bar Chuck Lever
Collet
Hood
Plunger Head
Finger Holder
Spindle
Hood
Collet
Stock

B. Set spindle speeds

(NOTE: There are several types of speed control devices. The method discussed here is for the twelve-speed head; see Figure 21.)

FIGURE 21


Forward/Reverse
Clutch Lever
Triple Gear
Shift Lever
Left-Hand, Double-Gear
Shift Lever
Right-Hand,
Double-Gear
Shift Lever

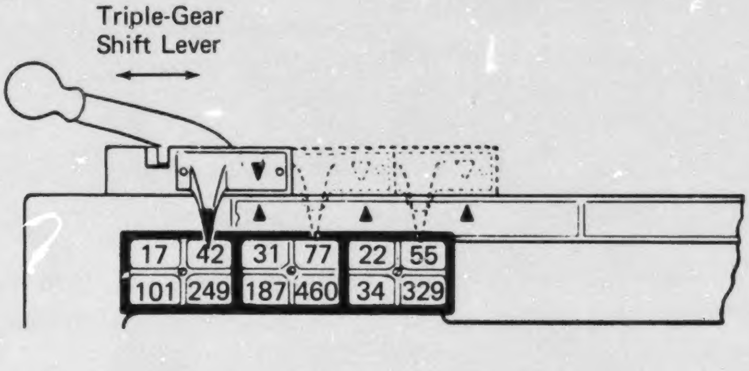
JOB SHEET #1

1. With clutch lever in disengaged position, move triple-gear shift lever to first group of four speeds so that pointer is over number 42 (Figure 22)

   (NOTE: Speed changes cannot be made for next operation; changes of the shift levers are made between operations only.)

   CAUTION: When shifting any gear lever, the forward and reverse clutch lever must be disengaged.

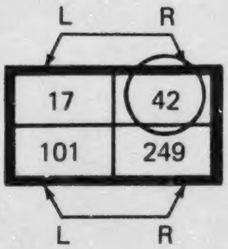
FIGURE 22



2. Pull left-hand, double-gear shift lever to right

   (NOTE: With the left-hand, double-gear shift lever to the right, the speed will be one of the two speeds shown in the right-hand set of the group of four speeds. With the left-hand, double-gear shift lever to the left, the left-hand set of two speeds is selected, Figure 23.)

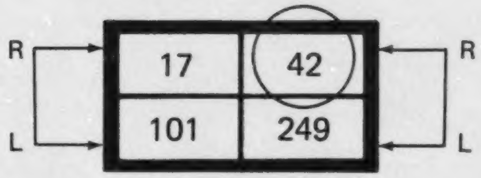
FIGURE 23



3. Pull right-hand, double-gear lever to right

   (NOTE: With the right-hand, double-gear shift lever to the right, the speed will be one of the two speeds shown in the upper set of the group of four speeds. With the right-hand, double-gear shift lever to the left, the lower set of two speeds is selected, Figure 24.)

FIGURE 24



4. Engage clutch in forward position so that spindle will turn at 42 rpm

5. Disengage clutch; shift triple-gear lever to third group so that pointer is at 55; move left-hand shift lever to left, and leave right-hand shift lever at right

6. Engage clutch lever in forward position so that spindle will turn at 22 rpm

7. Disengage clutch lever

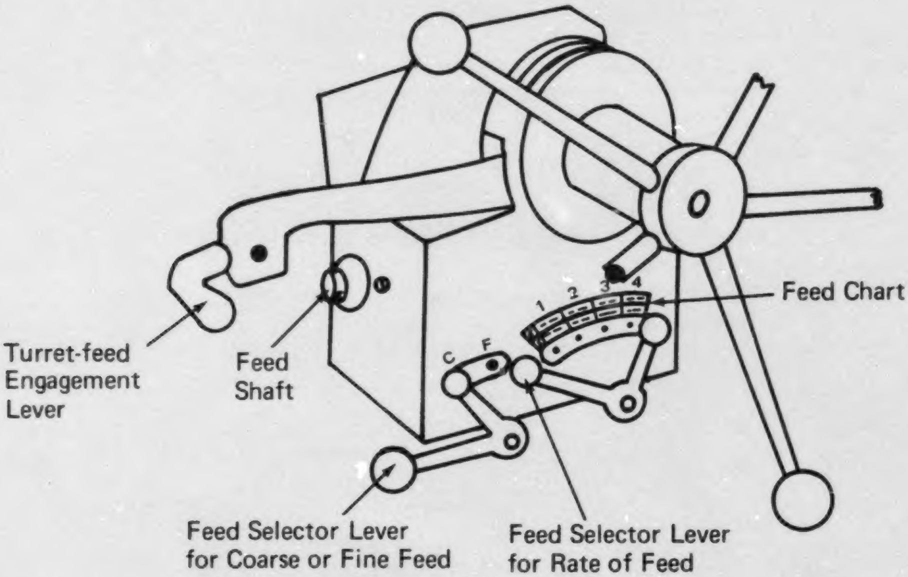
C. Set stop roll and turret feed

   1. Mount stop roll in Position 1 of hexagon turret; mount boring-bar holder and boring bar in Position 3

JOB SHEET #1

2. Shift feed levers (Figure 25)
   a. Move coarse-fine feed selector lever to Position C (coarse)
   b. Move feed selector lever to 0.020"

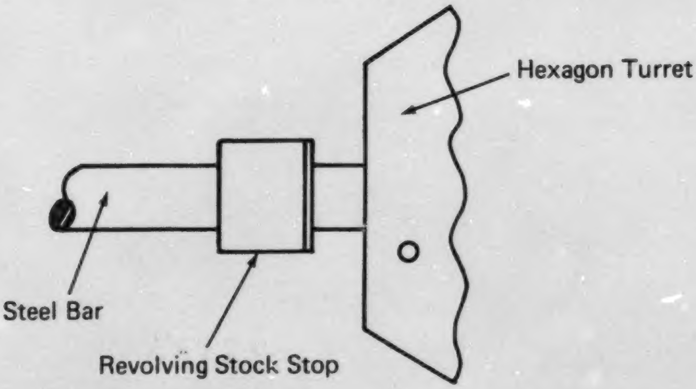
FIGURE 25


Feed Chart
1
2
3
4
C
F
Turret-feed Engagement Lever
Feed Shaft
Feed Selector Lever for Coarse or Fine Feed
Feed Selector Lever for Rate of Feed

3. Secure slide clamp (slide-binder lever)

4. With hexagon turret in Position 1, lift feed-engagement lever to slide turret forward until revolving stock-stop makes contact with steel bar (Figure 26)

FIGURE 26


Hexagon Turret
Steel Bar
Revolving Stock Stop

JOB SHEET #1

5. Adjust stop roll at end of slide for Postion 1 until it makes contact with dead stop

   (NOTE: Just before the screw makes contact with the dead stop, the feed lever will drop [disengage].)

6. Index hexagon turret to Position 3; move slide forward until cutting tool is directly above 1" line on steel bar; adjust stop roll as explained in Step 5

   (NOTE: A standard tool holder may be substituted for the boring bar.)

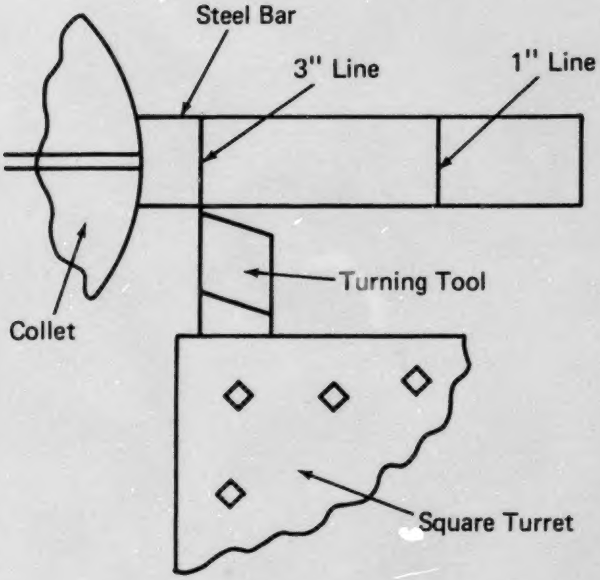
D. Adjust longitudinal-feed stop roll

1. Mount turning tool in Position 1 of square turret

2. Position turning tool to 3" line on steel bar (Figure 27)

   (NOTE: Turret lathes are designed to use a specific tool size to ensure that the cutting edge is at center height; if a smaller tool is used, it is necessary to shim the tool to put it at center height.)

FIGURE 27

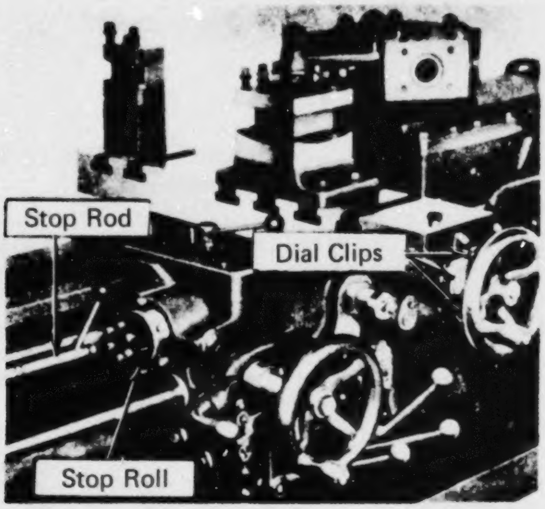


JOB SHEET #1

3. Slide out longitudinal stop roll until it is almost touching longitudinal stop-rod; turn stop roll to Position 1; adjust stop roll as on hexagon turret (Figure 28)

   (NOTE: Dial clips located on graduated collar of the cross feed are set to correspond to depth setting of the square turret and the rear-mounted tool.)

FIGURE 28



4. Set carriage feed by adjusting feed selector levers located on carriage apron

E. Have instructor check setup

TURRET LATHE OPERATIONS
UNIT IV

JOB SHEET #2--PRODUCE PART "A" ON THE TURRET LATHE

I. Equipment and materials

- A. Turret lathe with collet and bar feed, #2 or #3
- B. Aluminum rod, 2024T4, 3/8" diameter x 12' length
- C. Cutting tools for square turret
  1. Facing tool, 1/2" square
  2. Recessing tool, 1/2" square
  3. Chamfering tool, 1/2" square
  4. Turning tool, 1/2" square
- D. Self-releasing die head with 1/4-20NC chasers
- E. Stock stop
- F. Micrometer, 0" to 1"
- G. Steel rule, 6"
- H. Cutoff tool for backside toolholder
- I. Blueprint of key ring

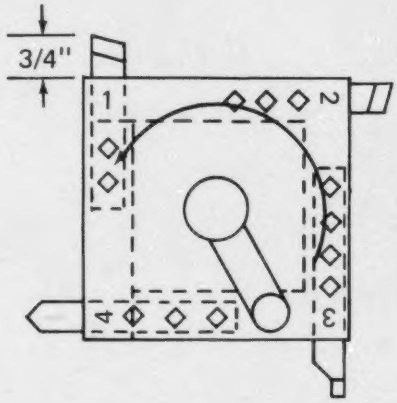
  (NOTE: This blueprint can be found in Assignment Sheet #2.)
- J. Vernier caliper, 6"
- K. Cutting fluid

JOB SHEET #2

II. Procedure

A. Mount cutting tools in square turret (Figure 29)

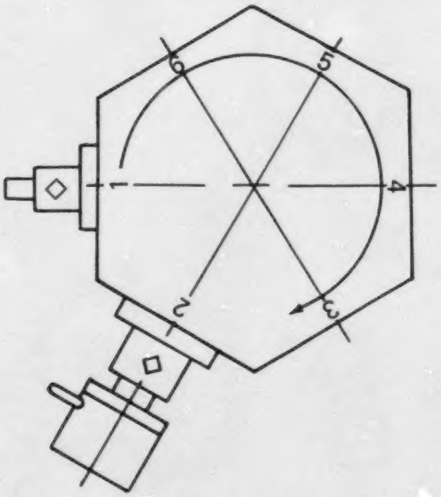
FIGURE 29



Position 1--Facing
Position 2--Turning
Position 3--Recessing
Position 4--Chamfering

B. Mount stock stop and self-releasing die in hexagon turret (Figure 30)

FIGURE 30

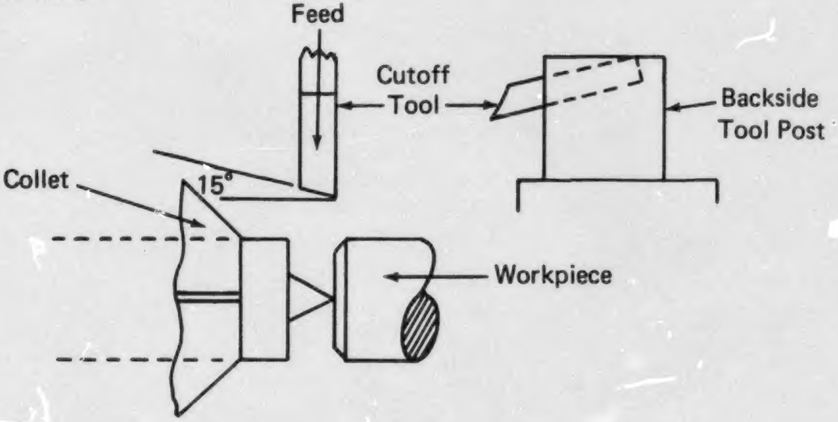


Position 1--Stock Stop
Position 2--Self-Releasing Die

JOB SHEET #2

C. Mount cutoff blade in backside tool post, with blade angled so that work is cut off clean (Figure 31)

FIGURE 31



D. Put material in bar feed

E. Pull collet chuck and bar-feed lever to right, unlocking collet

F. Slide work forward until material extends through collet about 1/2"; tighten bar-feed head

G. Turn on power and move collet chuck and bar-feed lever back and forth to see if it will move stock forward; readjust if necessary

H. Unlock collet and move slide forward with hexagon turret in position; allow stock stop to push stock back into collet until about 1 3/8" of material protrudes

I. Adjust stop screw for Position 1 of hexagon turret

J. Move stop roll back

K. Index square turret to position facing tool; move carriage so that facing tool is touching end of work

L. Turn longitudinal-feed stop roll to Position 1, and slide longitudinal stop-rod until it makes contact

M. Turn Position 1 stop screw to allow tool to move about 1/64"

(NOTE: By facing the end smooth, you will be sure that the work is the proper length.)

N. Set speed to correct rpm

O. With carriage against stop, start spindle and face end of work; stop spindle

JOB SHEET #2

P. Index square turret to Position 2; advance turning tool until it just touches end of work

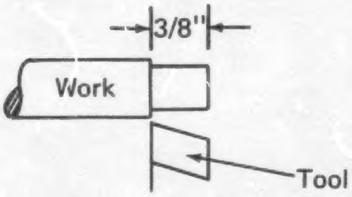
Q. Turn stop screw in until it reaches positive stop of carriage, and then turn stop screw out so that it allows tool to advance about 3/8"

(NOTE: The pitch of the screw will help you determine how much to turn the screw out.)

EXAMPLES: Thirteen threads per inch has a pitch of 0.077"; 4.9 complete revolutions of the screw will equal about 3/8"

R. With turning tool just touching outside diameter, start spindle and make a cut to check for length; adjust stop screw if necessary (Figure 32)

FIGURE 32

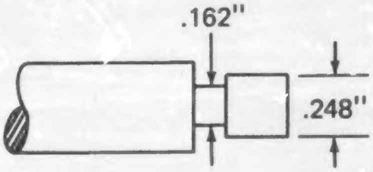


S. Apply cutting fluid as required and cut diameter down to 0.248" ± 0.001"; measure diameter to ensure proper setting, and then set Position 2 clip of square turret

T. Index square turret to Position 3 (recessing); move carriage to position tool so that it touches shoulder, and set longitudinal-feed stop roll

U. Start spindle and advance tool until it touches turned surface; note setting on graduated collar; apply cutting fluid as required and advance tool another 0.043"; set clip #3 (Figure 33)

FIGURE 33



V. Index hexagon turret to Position 3 (threading); turn turnstile until self-releasing die head is at end of work

W. Adjust stop screw forward to positive stop, and then screw it back about 0.312"

(NOTE: The feed of the slide should be about the same as the pitch of the threads.)

JOB SHEET #2

X. Set speed at about 100 rpm

Y. Adjust die head so that tripping mechanism will open die when it reaches the length of the slide stroke

Z. Move slide to rear position without indexing turret

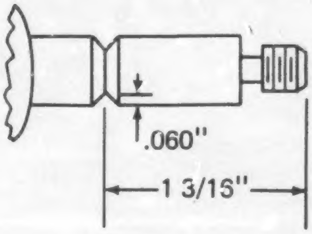
AA. Index square turret to Position 4 (chamfering); position carriage so that tool is at end of work, and position longitudinal-feed stop roll at Position 4

BB. Back tool away from work and move carriage so that point of chamfering tool is 1 3/16" from end of stock; set longitudinal-feed stop

CC. Engage feed-engagement lever of slide; apply cutting fluid as required and cut the threads; index hexagon turret back to Position 1

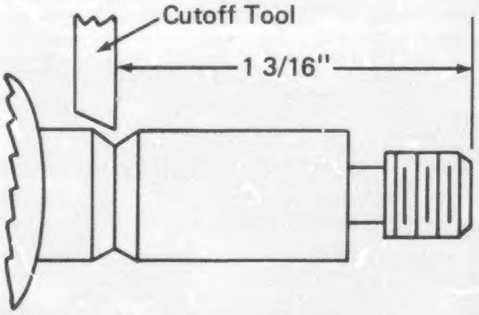
DD. Feed chamfer tool in until it contacts work; then feed in an additional 0.060" and set clip #4 (Figure 34)

FIGURE 34



EE. Move carriage so that point of cutoff tool will feed into bottom of groove just cut; set longitudinal-feed stop roll at Position 5 (Figure 35)

FIGURE 35



FF. Set speed to correct rpm

GG. Apply cutting fluid, and feed cutoff tool toward work until part drops off

JOB SHEET #2

HH. Index square turret and longitudinal stop to Position 1

II. Turn turnstile so that hexagon turret brings stock stop forward to position

JJ. Pull collet chuck and bar-feed lever and allow feed bar to bring stock out to stock stop; then push collet chuck and bar-feed lever back to lock collet

KK. Stop spindle; check part against blueprint specifications; make any required andjustment, and then make another part

LL. After all adjustments have been made and part is in tolerance, make ten good parts

MM. Clean work area and put away tools

TURRET LATHE OPERATIONS
UNIT IV

JOB SHEET #3--PRODUCE PART "B" ON THE TURRET LATHE

I. Equipment and materials

- A. Turret lathe with collet and bar feed
- B. Two-flute plug tap 1/4-20NC
- C. Releasing tap-holder
- D. Drill chuck (2 required) and adapters or holders

  (NOTE: One drill chuck may be replaced with center-drilling tool for hexagon turret.)
- E. Combination drill and countersink #3
- F. Drill, #7
- G. Cutting tools for square turret
  1. Facing tool, 1/2" square
  2. Chamfering tool, 1/2" square
- H. Cutoff tool for rear tool holder
- I. Stock stop
- J. Steel rule, 6"
- K. Aluminum rod, 2024T4, 3/8" diameter x 12' length
- L. Blueprint of key ring

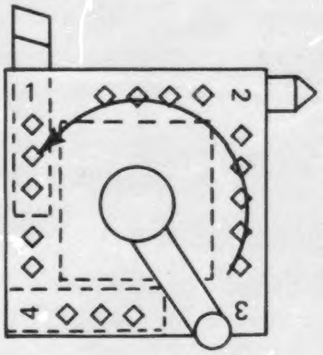
  (NOTE: This blueprint can be found in Assignment Sheet #2.)
- M. Cutting fluid

JOB SHEET #3

II. Procedure

A. Mount tools in square turret (Figure 36)

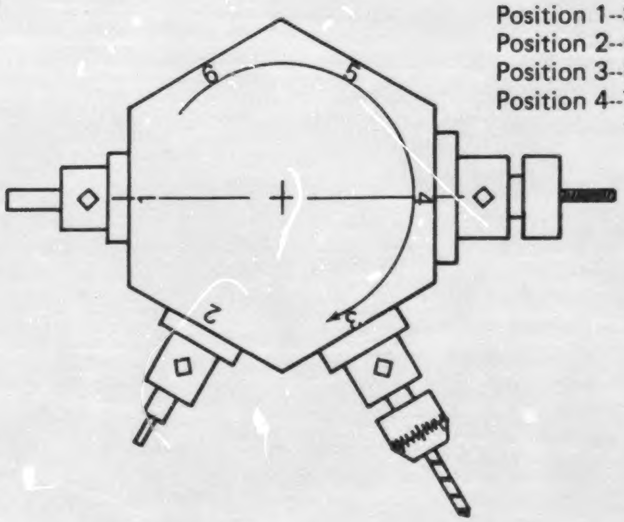
FIGURE 36



Position 1--Facing
Position 2--Chamfering

B. Mount center drill, #7 drill, 1/4-20NC tap, and stock stop in hexagon turret (Figure 37)

FIGURE 37



Position 1--Stock Stop
Position 2--Center Drill
Position 3--Drill
Position 4--Tap

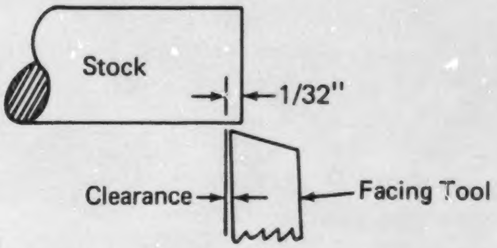
C. Mount cutoff blade in backside tool holder positioned for clean cutoff

D. Set stock stop about a 1 1/8" from end of collet, and adjust stop screw at end of hexagon turret

JOB SHEET #3

E. Move carriage so that Position 1 of square turret is over the part about 1/32" from end (Figure 38)

FIGURE 38



F. Adjust longitudinal-feed stop roll at Position 1 so that master stop screw is in contact with longitudinal-feed stop rod

G. Set rpm, start spindle, and face end of work smooth, applying cutting fluid as required

H. Stop spindle and withdraw tool; advance hexagon turret with turnstile until stock stop contacts work; set longitudinal-feed stop roll

I. Index hexagon turret to Position 2 (center drill); turn turnstile so that point of center drill touches end of work, and adjust stop-roll screw to positive stop; back it off about 0.25" (2 1/4 turns for 13 threads per inch)

J. Set speed to correct rpm

K. Start spindle and center drill, applying cutting fluid as required

(NOTE: The center-drilled hole diameter should not exceed three-fourths of the diameter of the drill.)

L. Stop spindle and set rpm for drilling

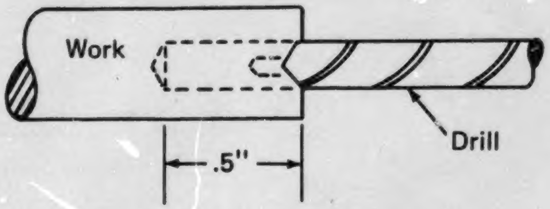
M. Index turret to Position 3 (#7 drill) and advance drill until it cuts its full width; stop spindle

N. Adjust stop-roll screw to positive stop, and then back it off 0.5" (6 1/2 turns for 13 threads per inch)

JOB SHEET #3

O. Start spindle and drill hole to depth, applying cutting fluid as required; withdraw tool and stop spindle (Figure 39)

FIGURE 39



P. Index hexagon turret to Position #4 (tap); move tap until it is near end of work

Q. Advance stop-roll screw until it hits the positive stop, and then back it off 0.375" (4.8 turns for 13 threads per inch)

R. Set rpm to 100 and start spindle; advance tap to depth, applying cutting fluid as required

(NOTE: Help the tap pull the slide by applying slight pressure to the turnstile by hand. When the tap has reached depth it will turn with the work.)

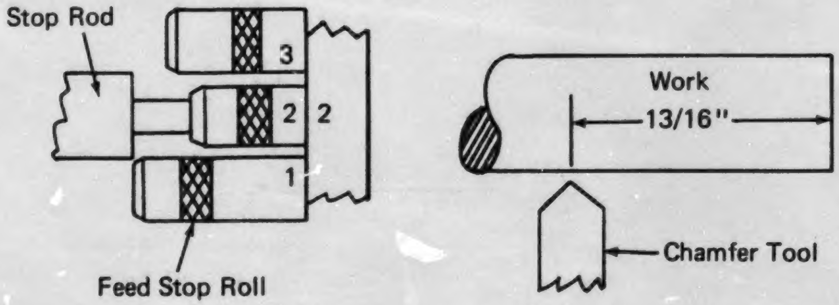
S. Reverse spindle and withdraw tap from hole with turnstile

T. Index hexagon turret to Position 1

U. Stop spindle and index square turret to Position 2 (chamfering)

V. Position chamfering tool 13/16" from end of part and set longitudinal-feed stop roll at Position 2 so that it is against stop rod (Figure 40)

FIGURE 40



JOB SHEET #3

W. Advance tool until it touches work; note crossfeed dial reading

X. Set rpm for chamfering and start spindle

Y. Apply cutting fluid as required and advance tool 0.060"; set clip #2; stop spindle and withdraw tool

Z. Turn square turret to Position 3; move carriage so that point of cutoff tool is at bottom of groove, positioned to make a clean cut; adjust longitudinal stop-rod so that it contacts master stop screw

AA. Set rpm and start spindle; cut off work, applying cutting fluid as required

BB. Stop spindle; check part against blueprint specifications; make any required adjustment. and then make another part

CC. After all adjustments have been made and part is in tolerance, make ten good parts

DD. Clean work area and put away tools

TURRET LATHE OPERATIONS
UNIT IV

TEST

NAME ____ SCORE ____________

1. Match terms associated with turret lathe operations to their correct definitions. Write the corret numbers in the blanks.

_____a. Stop that has a flat end with bearings, allowing it to revolve with work; mounted in a hexagon turret

_____b. Jaws made of a soft material cut or bored so that diameter or radius of jaw is same as work; used to chuck finished work surfaces

_____c. Rough casting, forging, or length of precut bar stock

_____d. Mechanical feed that moves bar through spindle to a positive stop

_____e. Work turned from individual piece of material while being held in chuck

_____f. Indexing toolholder that holds more than one tool

_____g. Thread-cutting portion of a die head; set of four numbered for size and number of threads per inch

1. Slug
2. Chucking part
3. Turret
4. Chasers
5. Stock stop
6. Bar feed
7. Soft jaws

2. Describe use of the turret lathe.

____

____

____

____

____

____

____

TEST

3. Match types of turret lathes to their correct descriptions. Write the correct numbers in the blanks.

_____a. Designed for larger work; hexagon turret and saddle unit move along bed ways; length of cut is limited by length of machine bed

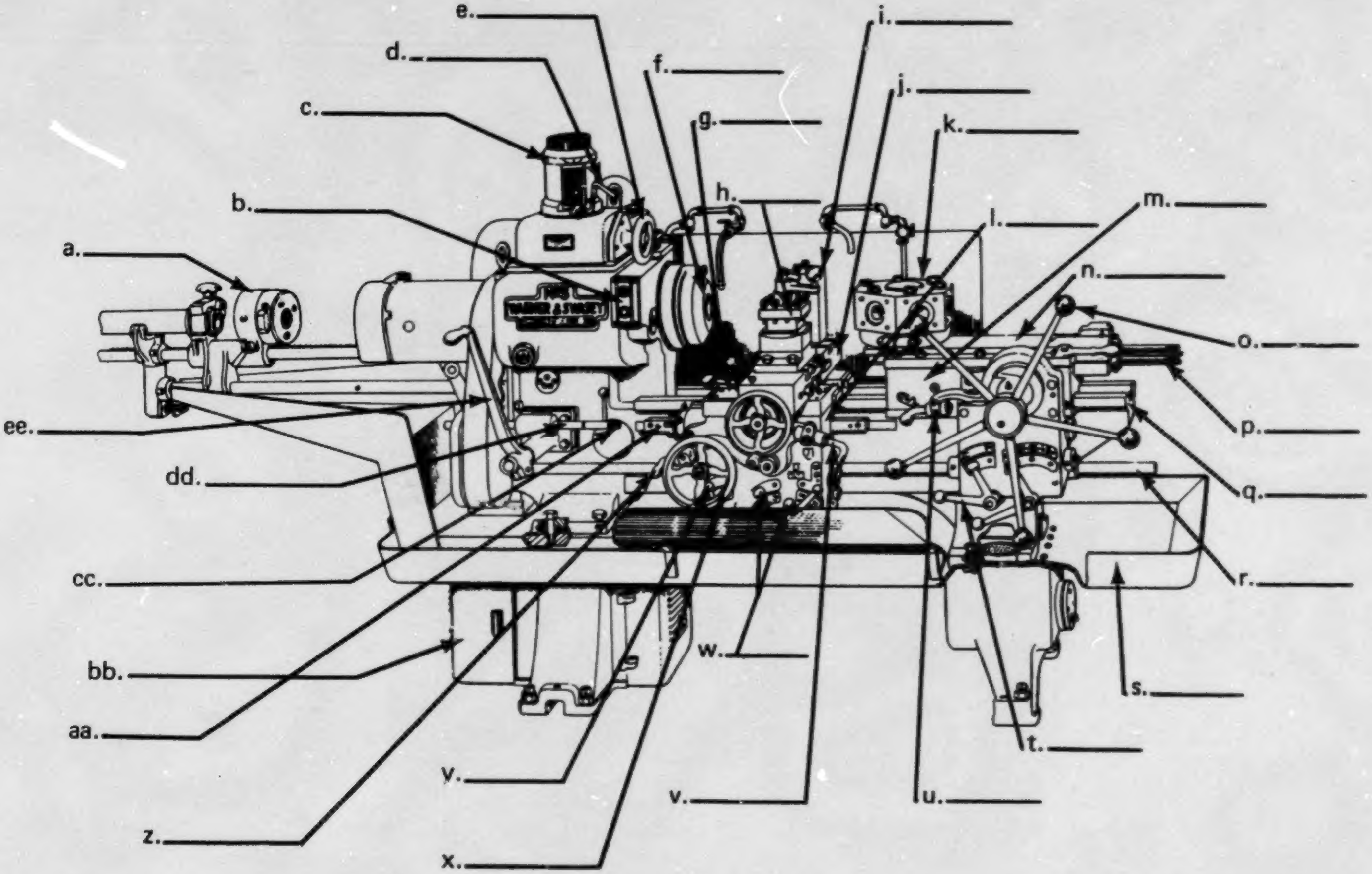
_____b. Designed so that chuck is horizontal, with a vertical slide and a hexagon turret mounted to a slide; chuck or work-holding device ranges in diameter from twenty-eight inches to ten feet; used primarily for large, heavy work

_____c. Easy-handling machine designed for bar stock work up to about three inches or chucking work up to about twenty inches in diameter; saddle remains fixed, and length of ram stroke varies with size of machine (four inches to thirteen inches)

1. Ram-type
2. Saddle-type
3. Vertical-type

TEST

4. Identify parts of the ram-type turret lathe. Write the correct numbers in the blanks. See next page.


a. ______
b. ______
c. ______
d. ______
e. ______
f. ______
g. ______
h. ______
i. ______
j. ______
k. ______
l. ______
m. ______
n. ______
o. ______
p. ______
q. ______
r. ______
s. ______
t. ______
u. ______
v. ______
w. ______
x. ______
y. ______
z. ______
aa. ______
bb. ______
cc. ______
dd. ______
ee. ______

TEST

1) Longitudinal stop rod
2) Collet chuck
3) Longitudinal-feed stop roll
4) Spindle control lever
5) Bar-feed head
6) Start/stop switch
7) Collet chuck and bar-feed lever
8) Preselector drum housing
9) Square turret
10) Preselector handwheel
11) Chip pan
12) Hydraulic pump and motor drive
13) Longitudinal-feed engagement lever
14) Feed reverse lever
15) Feed selector levers
16) Master stop screw
17) Cross slide
18) Carriage
19) Feed shaft
20) Turret slide
21) Turret-feed engagement lever
22) Turnstile
23) Stop rolls
24) Cross-feed engagement lever
25) Hexagon turret
26) Bed ways
27) Apron
28) Longitudinal-feed handwheel
29) Saddle
30) Backside tool post
31) Feed shift levers

TEST

5. Name basic operations performed on a turret lathe.

a. Hexagon turret

1) ______________________________
2) ______________________________
3) ______________________________
4) ______________________________
5) ______________________________
6) ______________________________
7) ______________________________
8) ______________________________
9) ______________________________
10) ______________________________
11) ______________________________
12) ______________________________
13) ______________________________
14) ______________________________

b. Square turret

1) ______________________________
2) ______________________________
3) ______________________________
4) ______________________________
5) ______________________________
6) ______________________________
7) ______________________________
8) ______________________________
9) ______________________________

TEST

c. Backside tool post

1) ____________________

2) ____________________

3) ____________________

4) ____________________

5) ____________________

6) ____________________

7) ____________________

8) ____________________

6. Name three methods of holding work.

a. ____________________

b. ____________________

c. ____________________

7. Match toolholders used in the hexagon turret to their correct descriptions/uses. Write the correct numbers in the blanks.

_____a. Used to turn work with single tool; can be adjusted

_____b. Allows reamer to seek its center

_____c. Used to center drill work that requires accuracy in location of center-drilled hole; support rollers help keep part concentric

_____d. Can be adjusted to form a straight or diamond knurl on work of different diameters

_____e. Used to work on long bars; has rollers to support the work

_____f. Used for cutting external threads; spring-loaded; pops open when preselected length is reached

_____g. Used for internal and external recessing and back facing, and for internal facing

_____h. Used to hold one or more tools to stagger cut, shape, form, or perform more than one operation at a time

1. Floating reamer-holder
2. Center-drilling attachment
3. Adjustable cutter-holder (precision)
4. Self-releasing die head
5. Adjustable knurl-holder
6. Bar-turner toolholder
7. Quick-acting slide tool
8. Multiple cutter-holder

TEST

______i. Used for tapping holes; thread chasers retract for removal

______j. Used to hold drills, drill chucks, and other tools; sometimes referred to as *bar-type holder*; has straight bore with clamping screws that hold tool or bushing adapters with straight or tapered bores

______k. Automatically releases, allowing tap to revolve with work when tap has reached preset depth

______l. Used in flanged toolholders; can be adjusted

______m. Allows tool to be adjusted off center for operations such as boring

______n. Used primarily to turn; can also hold drills, reamers, or boring tools; can be adjusted

______o. Used to hold drills, reamers, and center drills

______p. Enlarges an existing hole

9. Collapsible tap
10. Flanged tool-holder
11. Adjustable cutter-holder
12. Releasing tap-holder
13. Adjustable knee-tool
14. Slide tool-holder
15. Boring bar
16. Drill chuck

8. Arrange in order the steps to consider when planning sequence of operations. Write a "1" in the blank before the first step, a "2" before the second step, and so on.

______a. Examine blueprint for operations

______b. List where operations will be made (square turret, hexagon turret, backside tool post)

______c. Correlate sequence of operations and tool locations

______d. List operations and arrange in order to be performed

(NOTE: Test questions 9-11 list the assignment and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

9. Identify turret lathe operations and sequencing.
10. Plan sequence of operations for a turret lathe.
11. Demonstrate the ability to
    a. Use turret lathe controls and adjust stop rolls.
    b. Produce Part "A" on the turret lathe.
    c. Produce Part "B" on the turret lathe.

TURRET LATHE OPERATIONS
UNIT IV

ANSWERS TO TEST

1. a. 5
   b. 7
   c. 1
   d. 6
   e. 6
   f. 3
   g. 4

2. Description should include--Used to produce several identical parts by using several tools mounted in the hexagon turret, square turret, and backside tool post

3. a. 2
   b. 3
   c. 1

4. a. 5
   b. 6
   c. 8
   d. 4
   e. 10
   f. 2
   g. 18
   h. 9
   i. 30
   j. 17
   k. 25
   l. 29
   m. 27
   n. 20
   o. 22
   p. 23
   q. 26
   r. 19
   s. 11
   t. 15
   u. 21
   v. 24
   w. 31
   x. 28
   y. 14
   z. 13
   aa. 3
   bb. 12
   cc. 16
   dd. 1
   ee. 7

5. a. Hexagon turret
   1) Turning
   2) Facing
   3) Stock positioning
   4) Center drilling
   5) Drilling
   6) Reaming

ANSWERS TO TEST

   7) Threading with tap and die
   8) Threading with thread-cutting attachment
   9) Boring
   10) Taper cutting inside and outside
   11) Recessing
   12) Chamfering
   13) Knurling
   14) Forming

b. Square turret
   1) Turning
   2) Facing
   3) Knurling
   4) Forming
   5) Boring
   6) Recessing
   7) Chamfering
   8) Cutting off
   9) Tapering

c. Backside tool post
   1) Turning
   2) Facing
   3) Knurling
   4) Forming
   5) Recessing
   6) Chamfering
   7) Cutting off
   8) Tapering

ANSWERS TO TEST

6. Answer should include any three of the following
   - a. Collet
   - b. Three-jaw universal chuck
   - c. Air or hydraulic-operated chuck
   - d. Soft jaws on chuck
   - e. Fixture
   - f. Face plate

7. a. 3
   b. 1
   c. 2
   d. 5
   e. 6
   f. 4
   g. 7
   h. 8
   i. 9
   j. 10
   k. 12
   l. 11
   m. 14
   n. 13
   o. 16
   p. 15

8. a. 1
   b. 3
   c. 4
   d. 2

9. Evaluated to the satisfaction of the instructor

10. Evaluated to the satisfaction of the instructor

11. Performance skills evaluated to the satisfaction of the instructor